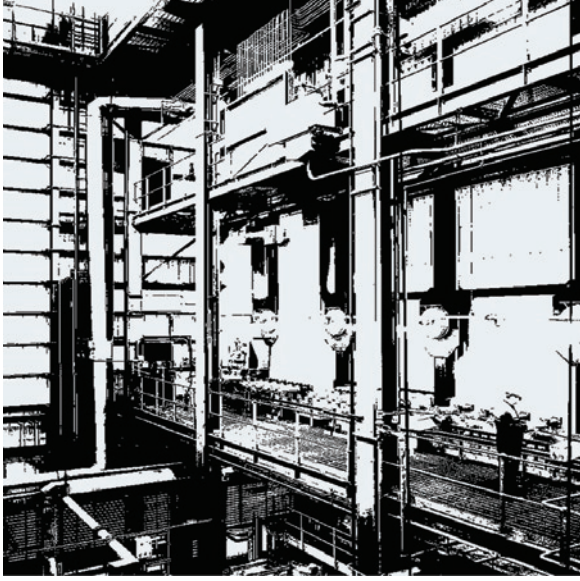
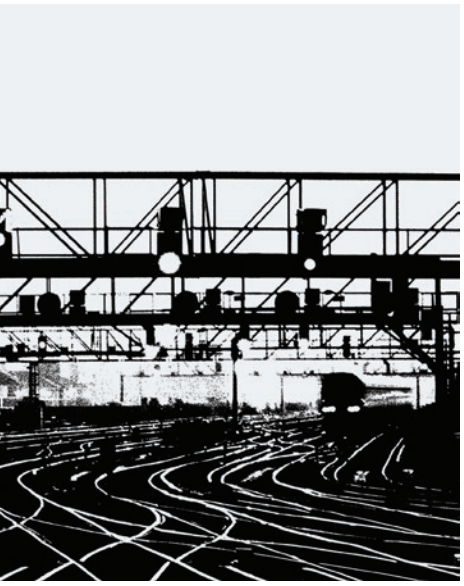



Crossbow®

2007

Wireless Sensor Networks

Product Reference Guide

APPLICATIONS

WIRELESS SENSOR NETWORKS

Wireless Sensor Networking enables more connectivity for sensor applications that will provide advanced monitoring, automation and control solutions for a range of industries.

The applications of Wireless Sensor Networks are almost limitless with many industries and applications having specific technology requirements such as reliability, battery life, range, frequencies, topologies, size of the network, sampling rate and sensor use.

To address the unique requirements of individual applications, Crossbow provides a broad portfolio of wireless sensor network products that allow our customers to choose the optimal solution for their industry, application and geographical requirements.

Industrial Automation

- Process Monitoring & Control
- Vibration Monitoring
- Oil and Gas Production & Distribution
- Security & Asset Protection
- Power Line Integrity & Monitoring

Building and Industrial Automation

- HVAC Controls
- Occupancy Monitoring
- Security, Asset Protection
- Security & Meter Readings

Supply Chain, Transportation, Location Tracking

- Asset Tracking
- Traffic Monitoring
- Secured Safety Zones

Environmental Monitoring

- Agricultural Monitoring
- Food Quality Monitoring
- Weather Monitoring
- Animal Tracking

PRODUCT PORTFOLIO

END TO END SOLUTIONS FOR WIRELESS SENSOR NETWORKS

Evaluation & Development Kits pg 5

- STARTER Kit
- PROFESSIONAL Kit
- OEM Design Kit
- Classroom Kit
- Cricket Kit
- Sensor Node
- Basestation Node

End-User Mote Systems pg 19

- MEP-SYS
- MEP410
- MEP510

Imote Platform pg 25

- Imote2 – IPR2400
- ITS400
- IIB2400

Processor/Radio Units & Modules pg 31

- IRIS
- IRIS OEM
- MICAz
- MICAz OEM
- MICA2 (900MHz)
- TELOSB
- MCS410

Sensor Boards pg 45

- MTS420 / 400
- MTS310 / 300 & MDA100
- MDA300
- MDA320

Gateways pg 51

- MIB510
- MIB520
- MIB600
- STARGATE

Software pg 57

- MoteWorks™ 2.0

How to Order pg 63

Limited Warranty & Limitation of Liability pg 64

PRODUCT REFERENCE GUIDE

END TO END SOLUTIONS FOR WIRELESS SENSOR NETWORKS

Product Upgrade

New Product

Imote2 Platform

Features	IPR2400	ITS400	IIB2400
Processor	13 - 416MHz MARVELL PXA271		
RAM	32MB		
Flash Memory	32MB		
Radio Transceiver	TI CC2420		
Frequency Range	2400-2483.5 MHz		
Temperature / Humidity		●	
Light		●	
Accelerometer (3-axis)		●	
I/O			2 Serial Ports via USB
ADC (4 external Inputs)		●	
JTAG			●

Mote Processor / Radio Platforms

Features	XM2110	M2110	MPR2400	MPR2600	MPR400
Frequency Range	2.4GHz ISM Band	2.4GHz ISM Band	2.4GHz ISM Band	2.4GHz ISM Band	868-870; 902-928 MHz
Processor	Atmel ATMega 1281	Atmel ATMega 1281	Atmel ATMega 128L	Atmel ATMega 128L	Atmel ATMega 128L
Radio Transceiver	RF230 Atmel	RF230 Atmel	TI CC2420	TI CC2420	TI CC1000
Serial Flash	Atmel AT45DB41B (512 kB)	Atmel AT45DB41B (512 kB)	Atmel AT45DB41B (512 kB)	Atmel AT45DB41B (512 kB)	Atmel AT45DB41B (512 kB)
RAM	8K bytes	8K bytes	4K bytes	4K bytes	4K bytes

Sensor Data Acquistion Boards

Features	MDA300	MDA320	MDA100	MTS300	MTS310	MTS400	MTS420
Accelerometer (2 Axis)					●	●	●
Actuator Relays	●						
Ambient Light						●	●
Barometric Pressure & Temp.						●	●
Buzzer				●	●		
External Analog Sensor Inputs	● (12-bit)	● (16-bit)	● (10-bit)				
GPS							●
GPIO	●	●	●				
Magnetic Field					●		
Microphone				●	●		
Photo-sensitive Light						●	●
Photoresistor			●	●	●		
Rel Humidity & Temperature	●					●	●
Thermistor			●	●	●		

Product Upgrade

New Product

Research Platforms

Features	TPR2420	MCS410 (Cricket)
Required Range	2400-2483.5 MHz	433-434.8 MHz
Processor	Texas Instruments MSP430	Atmel Atmega 128L
Radio Transceiver	TI CC2420	TI CC1000
Nonvolatile Memory	Atmel AT45DB41B (512 Kb)	Atmel AT45DB41B (512 Kb)
Light	●	
Ultrasonic / Range		●
Temperature	●	
Humidity	●	

Gateways & Network Interfaces

Features	MIB510	MIB520	MIB600	SPB400
Description	Serial Port Programmer	USB Programmer	Ethernet Port Programmer	Stargate, XScale Platform
Mote/Board Connectors	IRIS, MICAz, MICA2 MICA-sensor Boards	IRIS, MICAz, MICA2	IRIS, MICAz, MICA2	IRIS, MICAz, MICA2 PCMCIA, USB, RS-232, Compact Flash, RS-232, Ethernet
Programming Port	Serial (RS-232)	USB	Ethernet	With host PC: RS-232 or Ethernet (using ssh)
Data Port	Serial (RS-232)	USB	Ethernet	Various

EVALUATION & DEVELOPMENT KITS

DATASHEETS

- STARTER KIT
- PROFESSIONAL KIT
- OEM EDITION KIT
- CLASSROOM KIT
- CRICKET KIT
- SENSOR NODE
- BASESTATION

STARTER KIT

FOR WIRELESS SENSOR NETWORKS

- Out-of-the-box, Starter Kit for Wireless Sensor Networks
- Packaged, Pre-programmed Wireless Sensor Nodes for Temperature, Humidity, Barometric Pressure and Ambient Light Monitoring
- FCC and CE Certified*
- Reliable Networking Software for Self- forming, Self-healing Mesh Networks (XMesh)
- Gateway for Connecting Wireless Sensor Network with PC or Internet
- Windows® Based User Interface for Visualization and Analysis of Network and Sensor Data
- Support for Different ISM Frequencies

  - 2.4 GHz, 802.15.4/ZigBee

  - 868/916 MHz

Starter Kit

The Crossbow Starter Kit provides an easy and cost-effective solution to get first-hand experience with wireless sensor networks either in the 2.4GHz or 868/916 MHz ISM bands. This entry-level kit provides all the components needed for rapidly deploying a basic wireless sensor network. The sensor nodes and gateway are pre-configured with Crossbow's reliable, self-forming, self-healing mesh networking software (XMesh).

The MoteView application for Windows-based PCs provides an intuitive graphical user interface to monitor and manage the wireless sensor network. By displaying network topologies, charts and graphs of sensor readings, as well as configuring sensor nodes, MoteView lets the user understand the sensor data and network while allowing easy configuration of sensor nodes.

MoteWorks™
The development of custom sensor applications is enabled through Crossbow's MoteWorks™ software platform, which is available as an option with the kit. MoteWorks™ is specifically optimized for low-power battery-operated networks and provides support for:

- **Sensor Devices**: Network stack and operating system, standards support (802.15.4), over-the-air-programming and cross development tools.
- **Server Gateways**: Middleware for connecting wireless sensor networks to enterprise information and management systems.
- **User Interface**: Client application for remote analysis and monitoring, management and configuration of the sensor network.

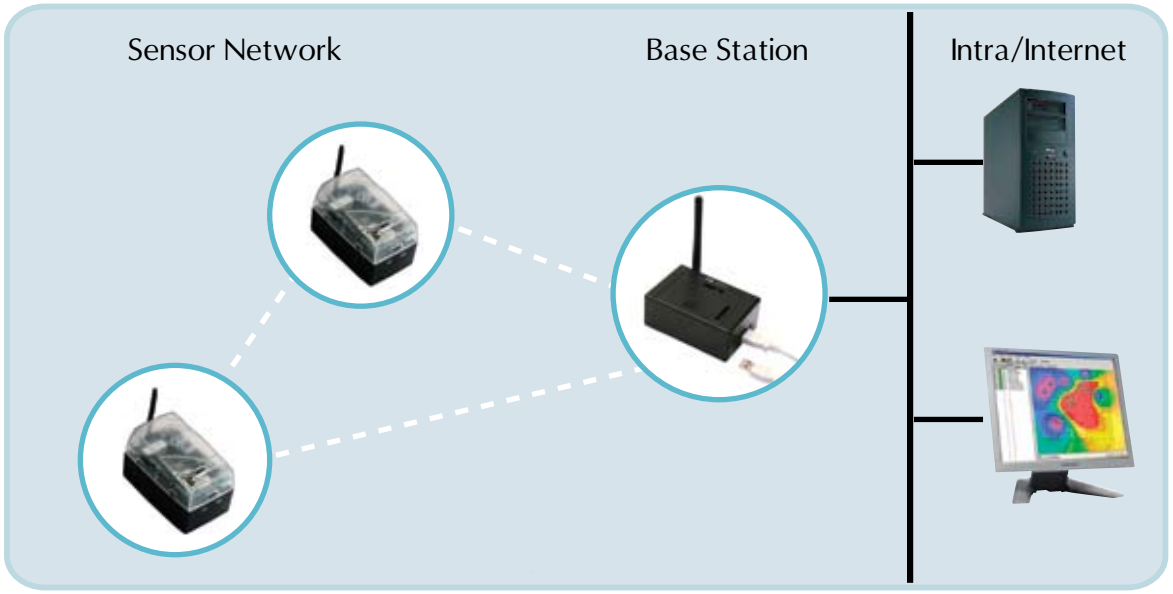
Ordering Information

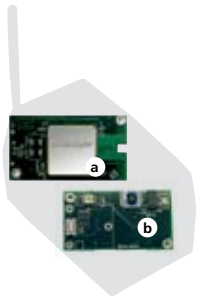
Model	Description
WSN-START900CA	MICA2 Starter Kit - 868/916 MHz
WSN-START2400CA	MICAz Starter Kit - 2.4 GHz

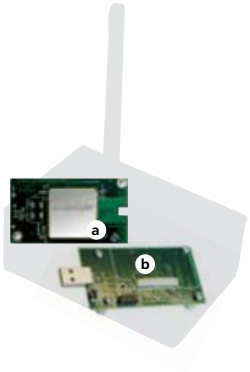
Document Part Number: 6020-0048-08 Rev A

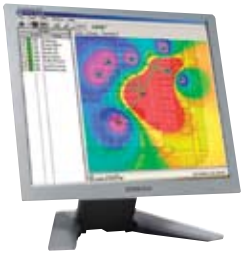
* FCC/CE certified for 2.4 GHz. Certification pending for 868/916 MHz.

Network Architecture









Sensor Node

a. Processor/Radio Board:
MICA modules to enable the low-power wireless sensor networks measurement system. Available in 868/916 MHz or 2.4 GHz.

b. Sensor Board:
MTS400 multi sensor board including temperature, humidity, barometric pressure and ambient light sensing capabilities.

Base Station

a. Processor/Radio Board:
MICA module functioning as a base station when connected to the USB PC interface.

b. USB PC Interface Board:
MIB520 Gateway provides a USB Interface for data communications.

Monitoring Software

MoteView Client:
Monitoring Software for historical and real-time charting; which also provides topology map, data export capability, mote programming and a command interface to sensor networks.

Kit Contents
2 Sensor Nodes (SN 2040/SN 9040)
1 Base Station (BU 2400/BU 900)
1 WSN Kit CD

Document Part Number: 6020-0048-08 Rev A

PROFESSIONAL KIT

FOR WIRELESS SENSOR NETWORKS

- Out-of-the-box Evaluation and Development Kit for Wireless Sensor Networks
- Packaged, Pre-programmed Wireless Sensors for Temperature, Humidity, Barometric Pressure and Ambient Light Monitoring
- FCC and CE Certified*
- Reliable Networking Software for Self- forming, Self-healing Mesh Networks (XMesh)
- Gateway for Connecting Wireless Sensor Network with PC or Internet
- Windows® Based User Interface for Visualization and Analysis of Network and Sensor Data
- Support for Different ISM Frequencies

  - 2.4 GHz, 802.15.4/ZigBee

  - 868/916 MHz

Professional Kit

The Crossbow Professional Kit provides a comprehensive and cost-effective platform for the evaluation and development of wireless sensor network applications either in the 2.4GHz or 868/916 MHz ISM bands. The professional kit provides all the components needed for rapidly deploying a multi hop wireless sensor mesh network. The sensor nodes and gateway are pre-configured with Crossbow's reliable, self-forming, self-healing mesh networking software (XMesh).

The MoteView application for Windows-based PCs provides an intuitive graphical user interface to monitor and manage the wireless sensor network including displaying network topologies, charts and graphs of sensor readings, as well as configuring sensor nodes.

MoteWorks™

The development of custom sensor applications is enabled through Crossbow's MoteWorks™ software platform, which is available as an option with the professional kit. MoteWorks™ is specifically optimized for low-power battery-operated networks and provides support for:

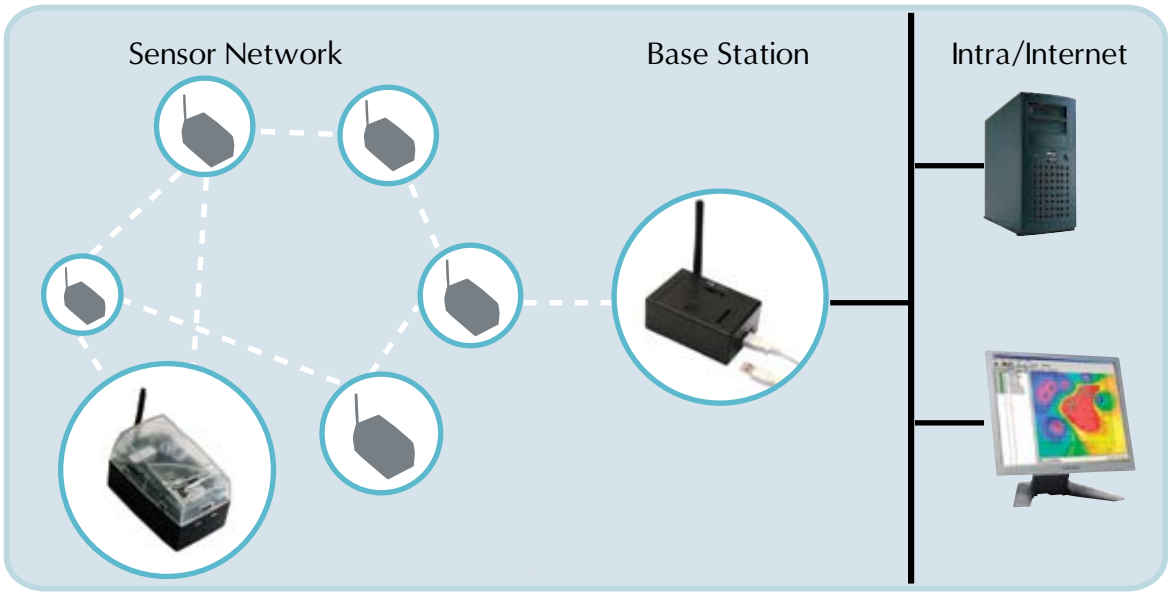
- **Sensor Devices**: Network stack and operating system, standards support (802.15.4), over-the-air-programming and cross development tools (XMesh).
- **Server Gateways**: Middleware for connecting wireless sensor networks to enterprise information and management systems (XServe).
- **User Interface**: Client application for remote analysis and monitoring, management and configuration of the sensor network.

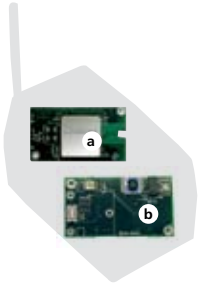
Ordering Information

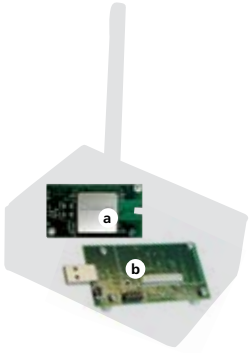
Model	Description
WSN-PRO900CA	MICA2 Professional Kit - 868/916 MHz
WSN-PRO2400CA	MICAz Professional - 2.4 GHz
WSN-PRO-MWE900CA	MICA2 Professional Kit - 868/916 MHz with MoteWorks Enterprise User License
WSN-PRO-MWE2400CA	MICAz Professional Kit - 2.4 GHz with MoteWorks Enterprise User License

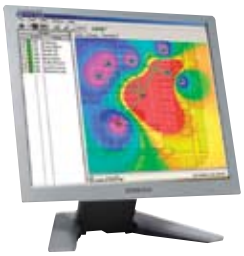
Document Part Number: 6020-0062-05 Rev A

Network Architecture









Sensor Node

a. Processor/Radio Board:
MICA modules to enable the low-power wireless sensor networks measurement system. Available in 868/916 MHz or 2.4 GHz.

b. Sensor Board:
MTS400 multi sensor board including temperature, humidity, barometric pressure and ambient light sensing capabilities.

Data Acquisition Board:
MDA320 is a high performance data acquisition board with up to 8 channels of 16-bit ADC analog input.

Base Station

a. Processor/Radio Board:
MICA module functioning as a base station when connected to the USB PC interface.

b. USB PC Interface Board:
MIB520 Gateway provides a USB Interface for data communications.

USB Programming Board:
MIB520 provides a USB interface for data communications.

Monitoring Software

MoteView Client:
Monitoring Software for historical and real-time charting. Provides topology map, data export capability, mote programming and a command interface to sensor networks.

Kit Contents
6 Sensor Nodes (SN 2040/SN 9040)
1 Base Station (BU 2400/BU 900)
1 Data Acquisition Board (MDA320)
1 USB Programming Board (MIB520)
1 WSN Kit CD

Document Part Number: 6020-0062-05 Rev A

OEM DESIGN KIT

FOR WIRELESS SENSOR NETWORKS

- OEM Design Kit for Wireless Sensor Network Devices
- Stamp-size Modules for Fast Integration of Wireless Processor/ Radios into Hardware Designs
- Pre-programmed Sensor Interfaces and Boards for Immediate Sensor Data Acquisition Capabilities
- Gateway for connecting Wireless Sensor Network with PC or Internet
- Windows® Based User Interface for Visualization and Analysis of Network and Sensor Data
- Support for 2.4 GHz, IEEE 802.15.4

Kit Contents
5 MICAz OEM Edition Modules
5 MICAz OEM Edition Reference Boards
3 MDA300 Sensor/Data Acquisition Boards
1 MDA100 Sensor/Data Acquisition Board
1 MIB600 Ethernet Gateway
1 Programming/Debugging Pod
1 OEM Module Programmer

OEM DESIGN KIT

The Crossbow OEM Design Kit supports fast development of wireless sensor network systems. The OEM Design Kit is targeted at applications using the 2.4 GHz frequency band. The kit provides users with OEM Edition Modules, a module programmer, pre-programmed reference design boards, sensor/data acquisition boards, a debug pod and a base station with Ethernet connectivity.

The MoteView application for Windows-based PCs provides an intuitive graphical user interface to monitor and manage the wireless sensor network. It enables users to display network topologies, charts and graphs of sensor readings, as well as configuring and managing sensor nodes.

Processor Radio Platforms

The stamp-size OEM processor/radio modules offer low-power radios for robust RF communication in the 2.4 GHz band use in a Direct Sequence Spread Spectrum (DSSS) radio. The 68-pin package is designed for easy sensor integration. Reference board design files/gerbers are provided for simplified OEM design integration.

Sensor Boards

The MDA300 sensor and data acquisition boards provide basic sensor capabilities for temperature and humidity as well as standard interfaces for connecting external sensors to the reference designs.

MoteWorks™

The development of custom sensor applications is enabled through Crossbow's MoteWorks™ software platform. MoteWorks™ can be specifically optimized for low-power battery-operated networks and provides support for:

- **Sensor Devices**: Network stack and operating system, standards support (802.15.4), over-the-air-programming and cross development tools.
- **Server Gateways**: Middleware for connecting wireless sensor networks to enterprise information and management systems.
- **User Interface**: Client application for remote analysis, monitoring, management and configuration of the sensor network.

Document Part Number: 6020-0107-05 Rev A

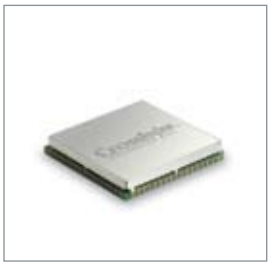
Kit Components

Reference Board

The OEM reference design board is a carrier PCB hosting the OEM module and providing antenna, batteries and a standard interface for connecting sensor boards.

OEM Edition Module

The stamp-size **OEM processor/ radio module** offers a low-power radio in the 2.4 GHz frequency band using a Direct Sequence Spread Spectrum (DSSS) radio.



Data Acquisition Board

The **MDA300CA** is a high-performance data acquisition board with up to 11 channels of 12-bit analog input and onboard temperature and humidity sensors.

Sensor Board

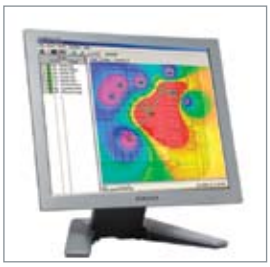
The **MDA100CB** sensor and data acquisition board has a precision thermistor, a light sensor/photocell and general prototyping area for connecting external sensors.

Gateway

The **MIB600** Gateway provides an Ethernet Interface and serves as a base station connecting the wireless sensor network to the IP network.

USB Programming Pod

The programming pod provides USB connectivity and supports programming of the OEM modules in custom hardware designs



MoteView Client

Monitoring Software for historical and real-time charting and sensor data analysis. Provides topology map, data export capability, mote programming and a command interface to sensor networks.

Module Programmer

The Module programmer supports programming of the stand-alone OEM modules before being placed onto the PCB.

Ordering Information

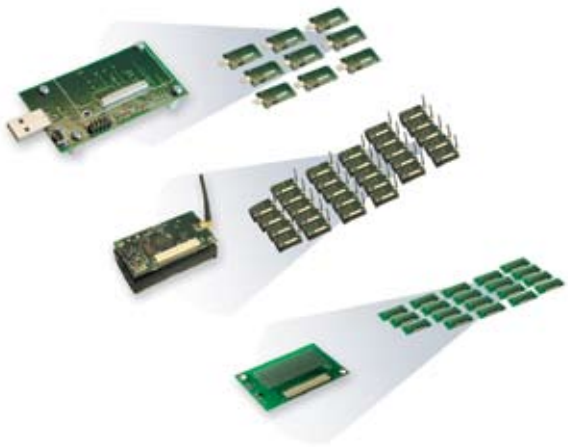
Model	Description
WSN-OEM2400CA	OEM Design Kit - 2.4 GHz

Document Part Number: 6020-0107-05 Rev A

CLASSROOM KIT

FOR WIRELESS SENSOR NETWORKS

Classsroom Kit



- Wireless Sensor Network Kit Designed Specifically for the Classroom or Teaching Lab
- Hardware & Software for Fast Lab Setup and Application Development
- Comprehensive Set of Teaching Materials
- MoteWorks™ Sensor Network Software Platform Based on TinyOS
- Reliable Networking Software for Self-healing, Self-forming Mesh Network (XMesh)
- Windows Based User Interface (MoteView)
- Easy Classroom Deployment
- Low-cost Introduction to Next Generation Technology

Crossbow actively supports academic programs in wireless and sensor technologies. Instructors in multiple departments are teaching various courses for wireless sensor technology based on Crossbow products.

Wireless sensor hardware and modules, in conjunction with the MoteWorks™ TinyOS based software platform, are ideal for the classroom. Classroom kits allow students to easily develop and build prototype sensor networks individually or in groups.

Crossbow's MICAz and MICA2 motes are the hardware platform of choice for a large number of wireless sensor network research papers published globally, as well as large-scale testbed deployments.

The kit also provides access to in-depth teaching materials, based on Crossbow's world-renowned training program, which is proven with thousands of Crossbow's customers globally.

A copy of Ivan Stojmenović's *Handbook of Sensor Networks* is included; it provides a broad coverage of WSN topics exploring various architectures and algorithms for applications, sensor training, security, and many other critical issues.

This integrated approach of hardware, mesh networking software and training materials allow educators to quickly develop and set up a comprehensive class and lab for leading edge wireless sensor network technology.

The classroom kits are beneficial for the typical teaching lab or sensor class project, getting students up and running quickly and economically. Students will benefit from comprehensive hands-on training involving all aspects of both the hardware and software applications.

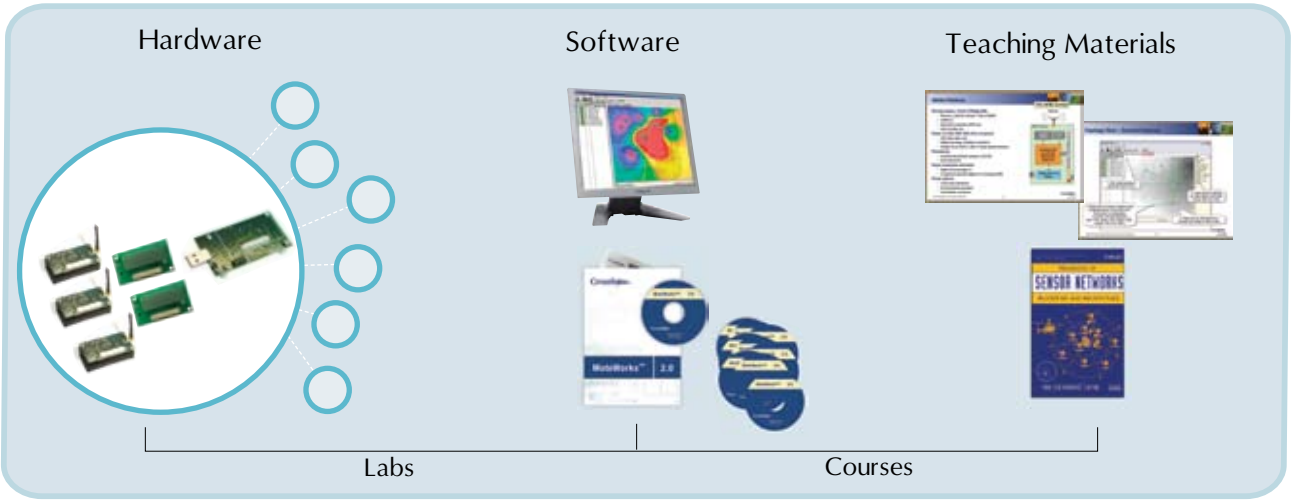
In addition to these standard kits, a variety of custom configurations are also available. Please contact Crossbow for additional details. Information on several prominent Universities which have programs dedicated to WSN is available at: http://www.xbow.com//Industry_solutions/Academic_Programs.aspx

Ordering Information

Model	Description
WSN-EDU900CA	MICA2 Classroom Kit - 868/916 MHz
WSN-EDU2400CA	MICAz Classroom Kit - 2.4 GHz

Document Part Number: 6020-0056-04 Rev A

Classroom Kit Architecture



Hardware

Lab Station Equipment

a. Processor/Radio Board:
MICA modules enable the low-power wireless sensor network measurement system, available in 868/916 MHz or 2.4 GHz.

b. Sensor Board:
MDA100 sensor and data acquisition board includes a precision thermistor, a light sensor/photocell and provides a general prototyping area.

c. USB PC Interface Board:
MIB520 Gateway provides a USB Interface for data communications.

Kit Contents
10 Lab Stations Include:
• 30 Processor/Radio Boards
• 20 Sensor Boards
• 10 Gateways
• 10 Seats MoteWorks License
• 1 Teaching Materials CD-ROM
• 1 Text Book

Software

MoteWorks™

Development of custom sensor applications is enabled through Crossbow's MoteWorks™ software platform, included in the classroom kit.

Sensor Devices: Network stack (XMesh) and operating system, standards support (802.15.4), over-the-air-programming and cross development tools.

Server Gateways: Middleware for connecting wireless sensor networks to enterprise information and management systems (XServe).

User Interface: Client application for remote analysis and monitoring, management and configuration of the sensor network.

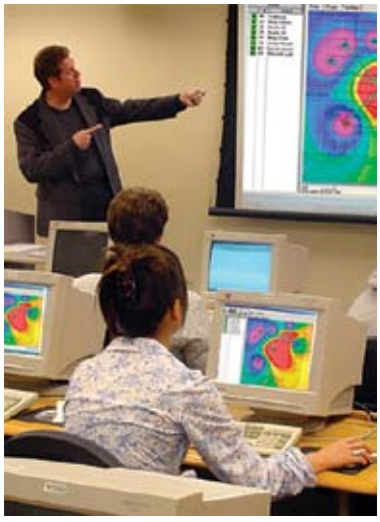
The Classroom kit includes one MWA-MoteWorks Academic License for the instructor with full email support and nine MWC-MoteWorks Classroom licenses for each student or groups of students (this license is not eligible for support).

Teaching Materials

Curriculum Tools

Included in each classroom kit is a CD-ROM containing the files for the presentations used in our world-renowned training courses. These materials may be modified and integrated into lectures and labs as the course curriculum requires.

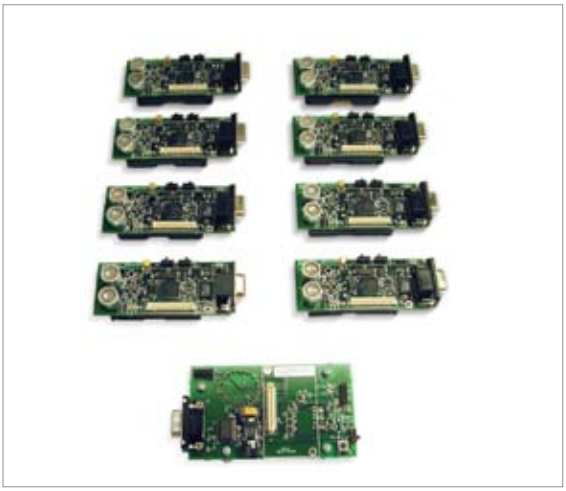
The included text book is the suggested reading for professors developing the course with theoretical and practical coverage and exercises. Please consult the website for additional options.



Document Part Number: 6020-0056-04 Rev A

CRICKET-KIT

MCS MOTE DEVELOPER'S KIT



- MICA2-Based Wireless Location Development System
- Centimeter-Level Accuracy with Decentralized and Scalable Operation
- Standard 51-Pin MICA2 Interface
- TinyOS Cricket Software with Visualization Tools

Applications

- Context-Aware Mobile Navigation Devices
- Indoor Location Systems for Asset and Resource Tracking
- Ubiquitous Computing

Cricket Deployment

MCS410 SERIES

The Cricket Developer's Kit, MCS-KIT410CA, is an entry-level kit for Wireless Location System Development. It features Crossbow's MCS series Cricket Mote (MCS410CA). The MCS410CA is a location-aware version of Crossbow's popular MICA2 low-power Processor/Radio module. The MCS410CA includes all of the standard MICA2 hardware along with an ultrasound transmitter and receiver. The addition of this Ultrasound technology to existing RF devices allows the Cricket Mote to derive linear range estimates by establishing differential time of arrival between these two signals.

The MCS410CA can be configured as either a Listener or a Beacon. As a Beacon, the MCS410CA transmits concurrent RF and Ultrasound pulses that are then received by other Cricket Motes configured as Listeners. An individual Listener obtains distance estimates for a specific Beacon by running algorithms that compare RF and Ultrasound samples to establish the best correlation.

The MCS series kit has all of the components needed to develop, test and implement a wireless location system. The kit includes:

- 8 Cricket Motes (433MHz)
- 1 MIB510 Programming and Serial Interface Board with DB-9 (Male-Female) RS-232 Cable
- Cricket Support Tools CDROM, Including Hardware User's Manual and TinyOS Getting Started Guide (PDF format)

More information on Cricket can be obtained at:
http://cricket.csail.mit.edu

More information on TinyOS can be obtained at:
http://webs.cs.Berkeley.edu

Ordering Information

Model	Description
MCS-KIT410CA	MICA2 Cricket Developer's Kit - 433 MHz
MCS410CA	433 MHz Cricket Mote Platform

Document Part Number: 6020-0082-01 Rev C

Sensor Node

FOR WIRELESS SENSOR NETWORKS

- Battery-operated Wireless Sensor Node for Temperature, Acceleration, Humidity, Barometric Pressure and Ambient Light Monitoring
- Plug-and-Play Add-on for Crossbow WSN kits
- Over-the-air-programming capabilities (OTAP)
- Programmable Processor/radio board with Pre-installed Networking Software for Self-forming, Self-healing mesh Networks
- Support for Different ISM frequency Bands:
  - 2.4 GHz, IEEE802.15.4
  - 868/916 MHz
- FCC and CE Certified*
- Packaged for indoor use

Applications

- Wireless Sensor Network Evaluation and Development
- Indoor Environmental Monitoring
- Asset Management (shock, temperature, humidity)
- Regulatory Compliance

WSN-KIT ADD-ON

Sensor Node

Crossbow's sensor nodes provide proven wireless technology and a comprehensive sensor suite in a fully integrated, battery-operated unit with indoor packaging. The integrated sensor board uses energy-efficient digital sensors for extended battery life and performance including a dual-axis accelerometer, barometric pressure, ambient light, and relative humidity and temperature sensors.

The nodes integrate a processor/radio board and antenna that are powered by two AA batteries. The SN24040 node provides a direct sequence spread spectrum radio (DSSS) supporting the 2.4 GHz global ISM band. The SN9040 node includes a frequency shift key radio (FSK) supporting the 868/916 MHz frequency band.

The sensor nodes come preprogrammed and configured with Crossbow's reliable, ad-hoc, low-power mesh networking software (XMesh). This provides plug-and-play network scalability for Crossbow's wireless sensor network Starter and Professional Kits.

The MoteView application for Windows-based PCs provides an intuitive graphical user interface to visualize the sensor data received from the sensor node and manage the wireless sensor network. MoteView is available for free download from Crossbow's web site.

Advanced Users

The sensor node's processor/radio boards are fully programmable and supported by Crossbow's MoteWorks™ software platform. MoteWorks enables the development of custom sensor applications that are optimized for low-power, battery operated, ad-hoc mesh networks.

Over-the-air-programming (OTAP) allows the sensor nodes to be updated with new firmware and applications without having to open the package or connect a programming cable. Over-the-air-programming provides for low-cost maintenance during deployment, especially for sensor nodes that are placed in remote locations.

* FCC/CE certified for 2.4 GHz. Certification pending for 868/916 MHz.

Document Part Number: 6020-0121-01 Rev A

Specifications	SN24040CA	SN9040CA	Remarks
Dual-Axis Accelerometer			
Range	+/- 2g		Analog Devices ADXL202JE
Resolution	2mg at 60Hz		
Non-linearity	0.2% of full scale		
Barometric Pressure Sensor			
Range	300-1100 mbar		Intersema MS5534AM
Resolution	0.1 mbar		
Accuracy	+/- 1.5% at 25 °C		
Ambient Light Sensor			
Spectral Responsivity	400-1000 nm		TAOS TSL255OD
Relative Humidity & Temperature Sensor			
Humidity Range	0-100% RH		Sensirion SHT11
Humidity Resolution	0.03% RH		
Absolute RH Accuracy	+/- 3.5% RH		
Temperature Range	-20 °C to +71 °C		
Temperature Resolution	0.01 °C		
Temperature Accuracy	+/- 0.5C @ 25 °C		
RF Transceiver			
Frequency Band	2.4 GHz	868/916 MHz	ISM bands
Indoor Range	30m	60m	Line of sight
Data Rate	250 kbps	38.4 kbps	
RF Power	+0dBm (max)	+5dBm (max)	Programmable
Receive Sensitivity	-94 dBm	-98 dBm	Programmable
Processor Performance			
Program Flash Memory	128K bytes		
Measurement (Serial) Flash	512K bytes		>100,000 Measurements
EEPROM	4K bytes		
Electomechanical			
Size	63mm x 38mm x 43mm		Excluding antenna
Weight	91 grams		
Batteries	2x AA		
Antenna	$^1/_4$ wave dipole		
System			
Power	2.7 - 3.3V		
Operating Temperature Range	-10 °C to + 60 °C		

WSN-Professional Kit

WSN-Starter Kit

Development Kits

Crossbow's Starter and Professional Kits for Mote development provide an easy way to get first-hand experience and develop real-world wireless sensor networks. These kits provide all the components needed for rapidly deploying wireless sensor networks with sensor nodes and gateways pre-configured with Crossbow's XMesh software.

Ordering Information

Model	Description
SN24040CA	2.4 GHz, packaged wireless sensor node
SN9040CA	868/916 MHz, packaged wireless sensor node

Document Part Number: 6020-0121-01 Rev A

Base Station

FOR WIRELESS SENSOR NETWORKS

- Base Station for Wireless Sensor Networks with Pre-installed Mesh Networking Software
- PC Connection through USB Interface
- Powered via USB Bus
- Support for Different ISM Frequency Bands
  - 2.4 GHz, IEEE802.15.4
  - 868/916 MHz
- FCC and CE Certified*
- Packaged for indoor use

Applications

- Wireless Sensor Network Evaluation and Development
- Indoor Environmental Monitoring
- Asset Management
- Regulatory Compliance

WSN-KIT ADD-ON

Base Station

Crossbow's base station offers proven wireless technology in a fully integrated package to serve as a connection between a wireless sensor network and PC. The base station integrates a processor/radio board, antenna and USB interface board which is preprogrammed with Crossbow's reliable, ad-hoc, low-power mesh networking software (XMesh) for communication with Crossbow's wireless sensor nodes (SN24040 or SN9040).

The BU2400 node provides a direct sequence spread spectrum radio (DSSS) supporting a wireless sensor network operating in the 2.4 GHz global ISM band. The BU900 node includes a frequency shift key radio (FSK) supporting wireless sensor networks operating in the 868/916 MHz frequency band.

The USB interface is used for data transfer between the base station and the MoteView application running on a Windows-based PC. MoteView provides an intuitive graphical user interface to visualize the sensor data received from the sensor nodes and manage the wireless sensor network. MoteView is available for free download from Crossbow's web site.

Specifications	BU2400CA	BU900CA	Remarks
RF Transceiver			
Frequency Band	2.4 GHz	868/916 MHz	ISM bands
Indoor Range	30m	60m	Line of sight
Data Rate	250 kbps	38.4 kbps	
RF Power	+0dBm (max)	+5dBm (max)	Programmable
Receive Sensitivity	-94 dBm	-98 dBm	Programmable
Processor Performance			
Program Flash Memory	128K bytes		
Measurement (Serial) Flash	512K bytes		
EEPROM	4K bytes		
Electromechanical			
Size	104mm x 64mm x 40mm		Excluding antenna
Weight	114 grams		
Power Supply	USB bus		
Antenna	$^1/_4$ wave dipole		
Operating Temperature Range	-20 C to + 70 °C		

* FCC/CE certified for 2.4 GHz.
Certification pending for 868/916 MHz.

Ordering Information

Model	Description
BU2400CA	2.4 GHz, packaged wireless sensor network base station
BU900CA	868/916 MHz, packaged wireless sensor network base station

Document Part Number: 6020-0121-01 Rev A

END-USER MOTE SYSTEMS

DATASHEETS

- MEP-SYS
- MEP410
- MEP510

MEP-SYS

WIRELESS MICROCLIMATE MONITORING SYSTEM

- Expandable, Battery-Powered 6-Node Wireless Microclimate Monitoring System
- Multi-Function Light, Temperature, Barometric Pressure and Humidity Sensors
- Pre-Installed Software, Compatible with MoteView User Interface
- Reliable, Self-forming, Self-healing Mesh Network Software (XMesh™)
- Rapid Setup and Deployment

Applications

- Indoor/Outdoor Wireless Sensor Networks
- Environmental/Agricultural Monitoring and Analysis
- Equipment Diagnostics

MEP System Deployment

System Contents
• 2 MEP410s
• 4 MEP510s
• 1 MBR410 Serial Gateway
• MoteView Display and Analysis Software

Pre-Installed Climate Monitoring Software

MEP-SYS410CB

The MEP-SYS410 is a turnkey environmental monitoring system designed for online measurement of important environmental parameters including temperature, humidity, photosynthetic solar radiation and barometric pressure. In addition to nurseries and vineyards, the MEP system has also been deployed in a variety of remote or sensitive environmental habitats.

The MEP wireless microclimate monitoring system is pre-configured with Crossbow's reliable self-forming, self-healing mesh network technology (XMesh) which offers users increased radio coverage range and extended battery life. MEP-SYS allows for easy installation at multiple monitoring points while eliminating the need for wired repeater nodes.

Compared to traditional environmental dataloggers and wireless weather stations, the MEP-SYS410 wireless microclimate monitoring system enables cost-effective online information retrieval and analysis from an unlimited number of individual data collection points.

MEP network data is sent wirelessly to Crossbow's standard MBR410 Base Station, which then forwards the data to a RS-232 serial output for both data display and logging via Crossbow's MoteView user interface. In addition to a local host, MoteView software can also be installed on a remote PC using the included remote logging features. A USB interface is also available via an optional USB to Serial adapter.

Advanced Users

The MEP nodes are fully programmable and supported by Crossbow's MoteWorks™ software platform. MoteWorks enables the development of custom sensor applications that are optimized for low-power, battery operated, ad-hoc mesh networks.

Ordering Information

Model	Description
MEP-SYS410CB	MEP Microclimate Monitoring system
MEP410CB	433 MHz Microclimate Multi-Sensor Node
MEP510CB	433 MHz Microclimate Temperature/Humidity Node

Document Part Number: 6020-0097-02 Rev A

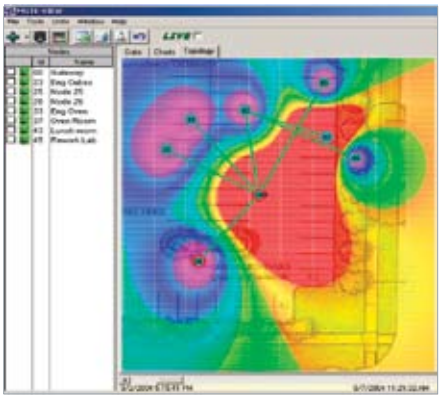
MEP410

MICROCLIMATE MULTI-SENSOR NODE

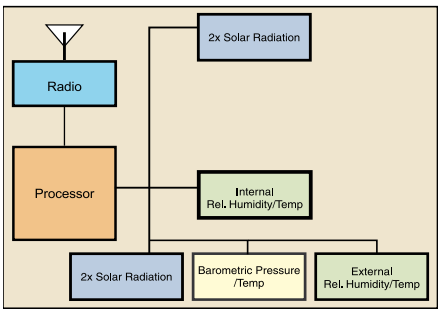
- Environmental Sensor Suite in Versatile Outdoor Packaging
- Reliable, Self-forming, Self-healing Mesh Network Software (XMesh™)
- Multi-Function Light, Temperature, Barometric Pressure and Humidity Sensors
- Pre-Installed Software, Compatible with MoteView User Interface

Applications

- Indoor/Outdoor Wireless Sensory Networks
- Environmental/Agricultural Monitoring and Analysis
- Equipment Diagnostics



MoteView Screen Shot



MEP410 Block Diagram

Pre-Installed Climate Monitoring Software

MEP410CB

The MEP410 microclimate multi-sensor node offers proven wireless technology and a comprehensive environmental sensor suite in a rugged outdoor package.

The MEP wireless microclimate monitoring system is pre-configured with Crossbow's reliable self-forming, self-healing mesh network technology (XMesh) which offers users increased radio coverage range and extended battery life. Individual MEP410 nodes can be purchased for use in stand-alone monitoring applications or to enhance or expand on existing MEP system deployments.

The MEP410 sensor suite includes dual sets of both total solar radiation and photosynthetic solar radiation sensors. The dual light sensor pairs are positioned to monitor incident and reflected sunlight. The MEP410 also features temperature, humidity, and barometric pressure sensors.

The MEP410 node includes a stand-alone external battery pack with two standard alkaline C-cell batteries. This battery pack is connected to the MEP410 via a durable six foot cable and provides an estimated 6000mAH of capacity. Typical battery life is approximately 2 years. The MEP410 has been deployed in a wide variety of both indoor and outdoor environments. Please contact Crossbow for additional information on current MEP410 system deployments.

Advanced Users

The MEP nodes are fully programmable and supported by Crossbow's MoteWorks™ software platform. MoteWorks enables the development of custom sensor applications that are optimized for low-power, battery operated, ad-hoc mesh networks.

Base Stations

The MEP410 communicates wirelessly with a base station either directly or via another MEP node using Crossbow's XMesh Network technology. Base station options include the self-contained MBR410 serial RS-232 gateway.

Document Part Number: 6020-0095-04 Rev A

Specifications		MEP410CB	Remarks
Temperature Sensor			
Range (°C)		-40 to +123[1]	Sensirion SHT11
Resolution (°C)		0.01	
Accuracy (°C)		± 0.5	At 25 °C
Humidity Sensor			
Range (RH)		0 to 100%	Sensirion SHT11
Resolution (RH)		0.03%	
Accuracy (RH)		± 3.5%	
Photysynthetic Radiation Sensor			
Range (nm)		320 to 730	(2) Hamamatsu S1087
Peak Wavelength (nm)		560	At 25°C
Photo Sensitivity (A/W)		0.3	
Total Radiation Sensor			
Range (nm)		190 to 1100	(2) Hamamatsu S1337- 33BQ
Peak Wavelength (nm)		960	At 25°C
Photo Sensitivity (A/W)		0.5	
Barometric Pressure Sensor			
Range (mbar)		300 to 1100	Intersema MS5534AM
Resolution (mbar)		0.1	
Accuracy (mbar)		1.5	
Temperature Range (°C)		-10 to +60	
RF Transceiver & Power			
Radio Frequency (MHz)		433	ISM band
Radio range (ft)		>500	1/4 wave dipole, elevated, LOS
RF power (dBm)		-20 to +5	
Battery Life (years)		2.0	Default Sampling Rate
Electromechanical			
Size:	(in)	3.50 x 2.00 x 1.25	Excluding battery pack
	(mm)	88.9 x 50.8 x 31.75	Excluding battery pack
Weight:	(oz)	4.5	
	(grams)	127.8	
Battery Pack		2x Alkaline C-cell	
Size:	(in)	3.50 x 2.00 x 1.25	
	(mm)	88.9 x 50.8 x 31.75	
Weight:	(oz)	13.7	Including Batteries
	(grams)	388	Including Batteries
Connector		6 pin Switchcraft	Waterproof

NOTE: [1] MEP unit qualified for -40 °C to + 85 °C

Bottom View

MEP410 with Battery Pack

MBR410 Mote Base Station

Ordering Information

Model	Description
MEP-SYS410CB	MEP Microclimate Monitoring system (2x MEP410CB, 4x MEP510CB, 1x MBR410CB)
MEP410CB	433 MHz Microclimate Multi-Sensor Node
MEP510CB	433 MHz Microclimate Temperature/Humidity Node
MBR410CB	433 MHz Serial Network Gateway
MEPC100CA	Advanced Programming Cable Kit
MIB510CA	MEP410, MEP510 Programming Board for Advanced Users

Document Part Number: 6020-0095-04 Rev A

MEP510

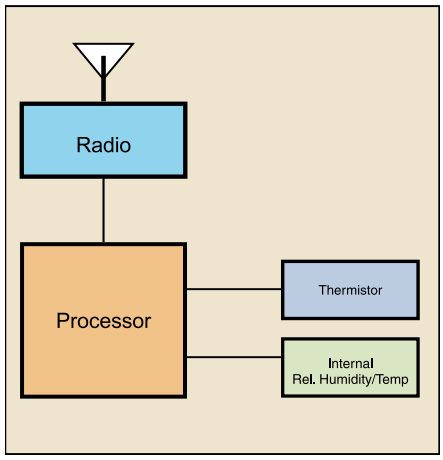
MICROCLIMATE TEMP/HUMIDITY NODE

- Environmental Sensor Node in Versatile Outdoor Packaging
- Reliable, Self-forming, Self-healing Mesh Network Software (XMesh™)
- Integrated Temperature and Relative Humidity Sensors
- Pre-Installed Software, Compatible with MoteView User Interface

Pre-Installed Climate Monitoring Software

Applications

- Indoor/Outdoor Wireless Sensory Networks
- Environmental/Agricultural Monitoring and Analysis
- Equipment Diagnostics



MEP510 Block Diagram

MEP510CB

The MEP510 microclimate sensor node offers proven wireless technology and an integrated digital temperature/ relative humidity sensor in a versatile outdoor package powered by a standard 2/3A lithium battery.

The MEP wireless microclimate monitoring system is pre-configured with Crossbow's reliable self-forming, self-healing mesh network technology (XMesh) which offers users increased radio coverage range and extended battery life. Individual MEP510 nodes can be purchased for use in stand-alone monitoring applications or to enhance or expand on existing MEP system deployments.

The MEP510's integrated temperature and humidity sensor is a low-power digital device, accurate to ± 2°C over a measurement range of -40°C to 85°C. The accompanying humidity sensor measures 0-100% relative humidity with typical accuracy of 3.5%. The MEP510 is powered by an internal battery pack with a battery life of approximately 6 months. A removable top mounting cover allows for easy field replacements. The MEP510 has been deployed in a wide variety of both indoor and outdoor environments. Please contact Crossbow for additional information on current MEP510 system deployments.

Advanced Users

The MEP nodes are fully programmable and supported by Crossbow's MoteWorks™ software platform. MoteWorks enables the development of custom sensor applications that are optimized for low-power, battery operated, ad-hoc mesh networks.

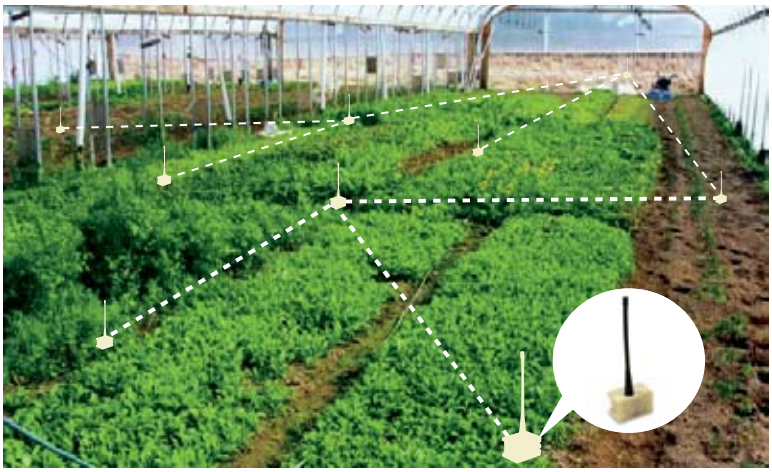
Base Station

The MEP510 communicates wirelessly with a base station either directly or via another MEP node using Crossbow's XMesh Network technology. Base station options include the self-contained MBR410 serial RS-232 gateway.

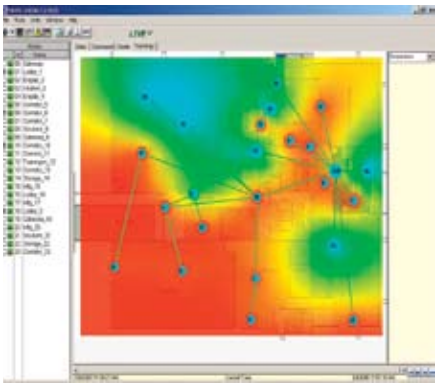
Document Part Number: 6020-0096-03 Rev A

Specifications		MEP510CB	Remarks
Temperature sensor			
Range (°c)		-40 to +123[1]	Sensirion SHT11
Resolution (°c)		0.01	
Accuracy (°c)		± 0.5	At 25 °C
Humidity Sensor			
Range (RH)		0 to 100%	Sensirion SHT11
Resolution (RH)		0.03%	
Accuracy (RH)		± 3.5%	
RF Transceiver & Power			
Radio Frequency (MHz)		433	ISM band
Radio Range (ft)		>500	1/4 Wave dipole, elevated, LOS
RF Power (dBm)		-20 To +5	
Battery Life (years)		0.5	Default Sampling Rate
Electromechanical			
Battery		1X 2/3A lithium	
Size	(in)	2.50 X 1.62 X 1.25	
	(mm)	63.5 X 41.3 X 38.10	
Weight	(oz)	3.2	Including Battery
	(grams)	89.8	Including Battery

NOTE: [1] MEP unit qualified for -40 °C to + 85 °C



Green House Deployment



MoteView Screen Shot

MBR410 Mote Base Station

Ordering Information

Model	Description
MEP-SYS410CB	MEP Microclimate Monitoring system (2x MEP410CA, 4x MEP510CA, 1x MBR410CA)
MEP410CB	433 MHz Microclimate Multi-Sensor Node
MEP510CB	433 MHz Microclimate Temperature/Humidity Node
MBR410CB	433 MHz Serial Network Gateway
MIB510CA	MEP410, MEP510 Programming Board for Advanced Users

Document Part Number: 6020-0096-03 Rev A

IMOTE BOARDS

DATASHEETS

- IMOTE2 – IPR2400
- ITS400
- IIB2400

Imote2

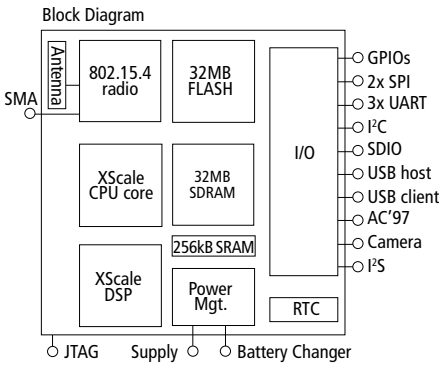
HIGH-PERFORMANCE WIRELESS SENSOR NETWORK NODE

- Intel PXA271 XScale® Processor at 13 – 416MHz
- Intel Wireless MMX DSP Coprocessor
- 256kB SRAM, 32MB FLASH, 32MB SDRAM
- Integrated 802.15.4 Radio
- Integrated 2.4GHz Antenna, Optional External SMA Connector
- Multi-color Status Indicator LED
- USB Client With On-board mini-B Connector and Host Adapters
- Rich Set of Standard I/O: 3xUART, 2xSPI, I²C, SDIO, GPIOs
- Application Specific I/O: I²S, AC97, Camera Chip Interface, JTAG
- Compact Size: 36mm x 48mm x 9mm

Applications

- Digital Image Processing
- Condition Based Maintenance
- Industrial Monitoring and Analysis
- Seismic and Vibration Monitoring

Block Diagram



Imote2

The Imote2 is an advanced wireless sensor node platform. It is built around the low power PXA271 XScale CPU and also integrates an 802.15.4 compliant radio. The design is modular and stackable with interface connectors for expansion boards on both the top and bottom sides. The top connectors provide a standard set of I/O signals for basic expansion boards. The bottom connectors provide additional high-speed interfaces for application specific I/O. A battery board supplying system power can be connected to either side.

Processor

The Imote2 contains the Intel PXA271 CPU. This processor can operate in a low voltage (0.85V), low frequency (13MHz) mode, hence enabling very low power operation. The frequency can be scaled from 13MHz to 416MHz with Dynamic Voltage Scaling. The processor has a number of different low power modes such as sleep and deep sleep. The PXA271 is a multi-chip module that includes three chips in a single package, the CPU with 256kB SRAM, 32MB SDRAM and 32MB of FLASH memory. It integrates many I/O options making it extremely flexible in supporting different sensors, A/Ds, radios, etc. These I/O features include I²C, 2 Synchronous Serial Ports (SPI) one of which is dedicated to the radio, 3 high speed UARTs, GPIOs, SDIO, USB client and host, AC97 and I²S audio codec interfaces, a fast infrared port, PWM, a Camera Interface and a high speed bus (Mobile Scaleable Link). The processor also supports numerous timers as well as a real time clock. The PXA271 includes a wireless MMX coprocessor to accelerate multimedia operations. It adds 30 new media processor (DSP) instructions, support for alignment and video operations and compatibility with Intel MMX and SSE integer instructions. For more information on the PXA271, please refer to the Intel/Marvell datasheet.

Radio & Antenna

The Imote2 uses the CC2420 IEEE 802.15.4 radio transceiver from Texas Instruments. The CC2420 supports a 250kb/s data rate with 16 channels in the 2.4GHz band.

The Imote2 platform integrates a 2.4GHz surface mount antenna which provides a nominal range of about 30 meters. For longer range a SMA connector can be soldered directly to the board to connect to an external antenna.

Power Supply

The Imote2 can be powered by various means:

Primary Battery: This is typically accomplished by attaching a Crossbow Imote2 Battery Board to either the basic or advanced connectors.

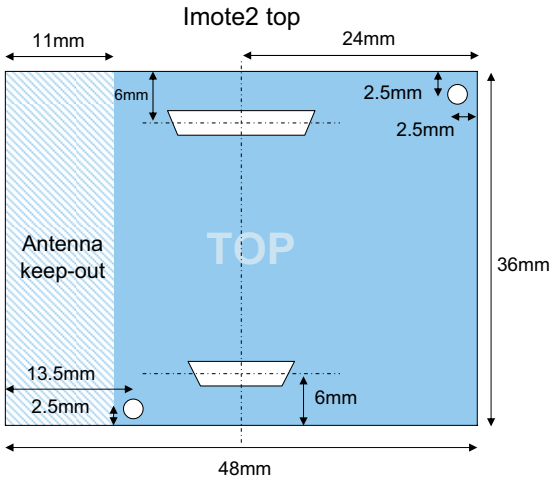
Document Part Number: 6020-0117-02 Rev A

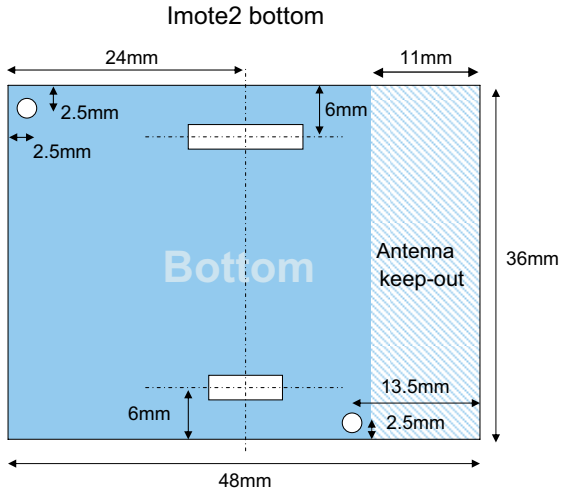
Rechargeable Battery: This requires a specially configured battery board attached to either the basic or advanced connectors. The Imote2 has a built-in charger for Li-Ion or Li-Poly batteries.

USB: The Imote2 can be powered via the on-board mini-B USB connector. This mode can also be used to charge an attached battery.

Battery Pads: A suitable primary battery or other power source can be connected via a dedicated set of solder pads on the Imote2 board.

Processor/Radio Board	IPR2400	Remarks
CPU		
Processor	Intel PXA271	
SRAM Memory	256 kB	
SDRAM Memory	32MB	
FLASH Memory	32MB	
POWER CONSUMPTION		
Current Draw In Deep Sleep Mode	390 µA	
Current Draw In Active Mode	31 mA	13MHz, radio off
Current Draw In Active Mode	44 mA	13MHz, radio Tx/Rx
Current Draw In Active Mode	66 mA	104MHz, radio Tx/Rx
Radio		
Transceiver	TI CC2420	
Frequency Band (ISM)	2400.0 – 2483.5 MHz	
Data Rate	250 kb/s	
Tx Power	-24 – 0 dBm	
Rx Sensitivity	-94 dBm	
Range (line of sight)	~30 m	With integrated antenna
I/O		
USB Client (mini-B), USB Host		
UART 3x, GPIOs, I^2C, SDI0, SPI 2x, I^2S, AC97, Camera		
Power		
Battery Board	3x AAA	
USB Voltage	5.0 V	
Battery Voltage	3.2 – 4.5 V	
Li-Lon Battery Charger		
Mechanical		
Dimensions Imote2 Board	36mm x 48mm x 9mm	
Weight	12g	





Document Part Number: 6020-0117-02 Rev A

Imote2
Battery Board

The universal battery board is designed to power the Imote2 using 3 primary AAA cells. Alternatively, rechargeable cells such as AAA NiMH can be used if charged separately.

The battery board can accommodate a plugged-in Imote2 via either the basic connectors (top) or the advanced connectors (bottom).

A mechanical switch on the side provides manual power shut-off. The battery board is fused for 500mA maximum current.

Battery Board	IBB2400CA
Batteries	3x AAA
Maximum Current	500mA Fused
Size	52mm x 43mm x 18mm
Weight with 3 AAA Batteries	51g
Weight without Batteries	14g

Imote2 Third Party Software

Several operating systems are available for Imote2 including TinyOS, Linux and SOS. Additional system software is available from Open Source.

For the latest operating systems and additional third party accessories please visit www.xbow.com.

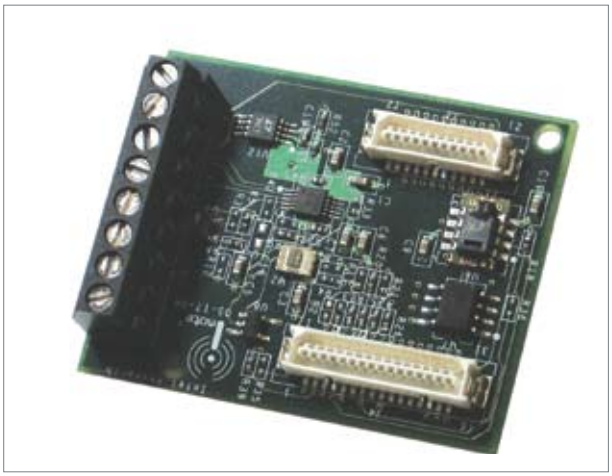
Ordering Information

Model	Description
IPR2400CA	Imote2 Board plus the Battery Board (included)
IBB2400CA	Imote2 Battery Board (stand-alone)
IIB2400CA	Imote2 Interface Board

Document Part Number: 6020-0117-02 Rev A

ITS400

IMOTE2 BASIC SENSOR BOARD



- Compatible With the Imote2 Processor/Radio Board
- Onboard 3-Axis Accelerometer, Temperature, Humidity, and Light Sensors
- 4 Channels of 12-bit Analog Input

Applications

- Wireless Sensor Networking
- Environmental Monitoring
- Asset Management (shock, temperature, humidity)
- Regulatory Compliance

ITS400

Developed by Intel Research lab and licensed to Crossbow, the ITS400 sensor board is designed to interface with the Imote2 platform. It contains a three-axis accelerometer, an advanced temperature/humidity sensor, a light sensor and a 4 channel A/D converter. The ITS400 allows stacking with other extension boards.

This versatile sensor board provides multiple sensing capabilities for the Imote2 in a wide variety of applications ranging from environmental monitoring to capturing vibration.

Specifications

Three-axis Accelerometer

- ST Micro LISL02DQ
- Acceleration Range, Resolution:
  - +/- 2g (12-bit)
- Communication Interfaces:
  - SPI, I2C

Temperature and Humidity Sensor

- Sensirion SHT15, 2 Channels:
- First Channel, humidity (12-bit):
  - 10-90%RH @ +/-2%RH
  - 0-100%RH @ +/-4%RH
- Second Channel, temperature (14-bit):
  - 0-40 °C @ +/-0.5 °C
  - -40-120 °C @ +/-2 °C

Digital Temperature Sensor

- TI TMP175 with I²C interface
- Temperature range, resolution: -25 °C – 85 °C @ +/-1.5 °C

Taos Light Sensor

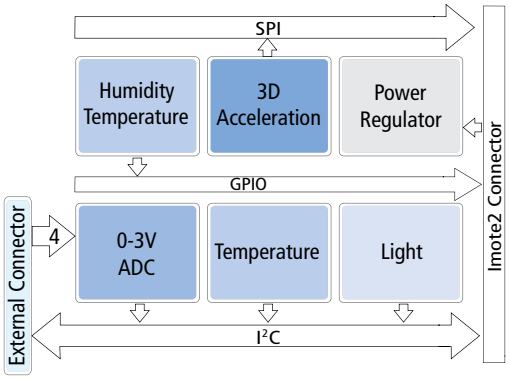
TAOS TSL2651with I²C interface, 2 Channels:

- First Channel Sensitivity (16-bit):
  - Visible Light and IR
- Second Channel Sensitivity (16-bit):
  - IR only

General Purpose ADC

- Maxim MAX1363 with I²C interface
- 4 channel analog (12-bit)
- Input signals range:
  - Analog 0-3V

Imote2 Basic Sensor Board



Model	Description
ITS400CA	Imote2 Basic Sensor Board

Document Part Number: 6020-0119-01 Rev A

IIB2400

IMOTE2 INTERFACE BOARD

- Interface Board for Imote2 Wireless Sensor Network
- JTAG Interface for Code Debugging
- USB Bus Power
- USB Port Programming for Imote2 Hardware Platform
- Dual USB Serial Ports

Applications

- USB Interface
- Debugging of Advanced Sensor Boards

IIB2400CA

The interface board is designed to provide dual USB serial ports and a JTAG interface for the Imote2. The interface board can be attached directly to the Imote2 using the advanced connector set. To facilitate the debugging of advanced sensor boards a second set of pass-through connectors is provided.

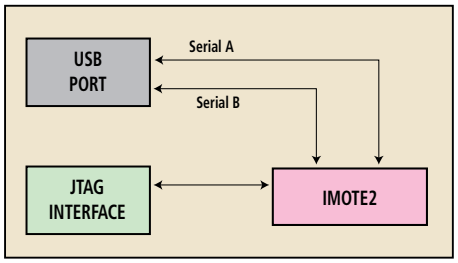
The interface board can be connected to a USB host, such as a PC, via the mini-B USB connector. A suitable mini-B to a USB cable is provided. The interface board with an attached Imote2 can also be powered using the USB connection. This power feature can be disabled using an on-board switch.

For PC USB connectivity, a driver for the on-board FTDI chipset is automatically loaded in Windows XP. For other operating systems, drivers can be downloaded from the FTDI Website http://www.ftdichip.com.

Communication activity is indicated by separate dual-color LEDs for each of the two serial ports (red/green for receive/transmit). The two USB serial ports are mapped to the Imote2's FF_UART and ST_UART, respectively. Standard baud rates from 110 to 921,600 bits per second are supported. Additionally, the FF_UART port supports hardware flow control via RTS/CTS signaling.

The JTAG connector provides a standard 20-pin interface that is compatible with standard adapters such as the Intel JTAG Cable (sold separately from Intel/Marvell). This allows the use of the Intel XScale Software Development Tool Suite or similar tools for SW development, debugging and reprogramming of the Imote2's FLASH memory.

The interface board can be configured for advanced use via several switches and by reprogramming the on-board CPLD.



IIB2400 Block Diagram

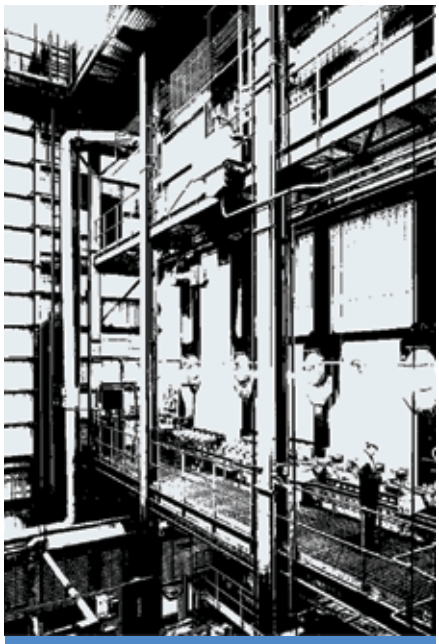
Ordering Information

Model	Description
IIB2400CA	Imote2 Interface Board

Interface Board	Imote2 IIB2400
Mote Connectors	2x Advanced (male/female)
USB Connector	mini-B Female
Serial Port A	Virtual UART With RTS/CTS Flow Control
Serial Port B	Virtual UART Without Hardware Flow Control
Serial Port Speed	110-921,600 Baud per Port
JTAG Port	Standard 20-pin Connector
Size	48mm x 36mm x 14mm
Weight	11g

Document Part Number: 6020-0122-01 Rev A

PROCESSOR/RADIO UNITS & MODULES



DATASHEETS

- IRIS
- IRIS OEM
- MICAz
- MICAz OEM
- MICA2 (900MHz)
- TELOSB
- MCS410

IRIS

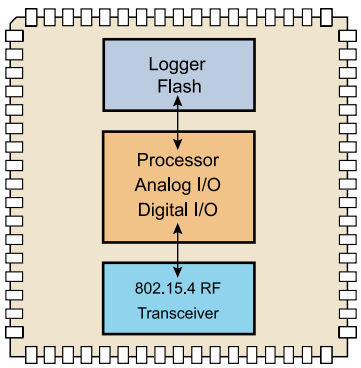
WIRELESS MEASUREMENT SYSTEM

- 2.4 GHz IEEE 802.15.4, Tiny Wireless Measurement System
- Designed Specifically for Deeply Embedded Sensor Networks
- 250 kbps, High Data Rate Radio
- Wireless Communications with Every Node as Router Capability
- Expansion Connector for Light, Temperature, RH, Barometric Pressure, Acceleration/Seismic, Acoustic, Magnetic and other Crossbow Sensor Boards

Applications

- Indoor Building Monitoring and Security
- Acoustic, Video, Vibration and Other High Speed Sensor Data
- Large Scale Sensor Networks (1000+ Points)

ZigBee™ Alliance



XM2110CA Block Diagram

IRIS

The IRIS is a 2.4 GHz Mote module used for enabling low-power, wireless sensor networks. The IRIS Mote features several new capabilities that enhance the overall functionality of Crossbow's wireless sensor networking products.

Product features include:

- Up to three times improved radio range and twice the program memory over previous MICA Motes
- Outdoor line-of-sight tests have yeilded ranges as far as 500 meters between nodes without amplification
- IEEE 802.15.4 compliant RF transceiver
- 2.4 to 2.48 GHz, a globally compatible ISM band
- Direct sequence spread spectrum radio which is resistant to RF interference and provides inherent data security
- 250 kbps data rate
- Supported by MoteWorks™ wireless sensor network platform for reliable, ad-hoc mesh networking
- Plug and play with Crossbow's sensor boards, data acquisition boards, gateways, and software

MoteWorks™ enables the development of custom sensor applications and is specifically optimized for low-power, battery-operated networks. MoteWorks is based on the open-source TinyOS operating system and provides reliable, ad-hoc mesh networking, over-the-air-programming capabilities, cross development tools, server middleware for enterprise network integration and client user interface for analysis and configuration.

Processor & Radio Platform

The XM2110CA is based on the Atmel ATmega1281. The ATmega1281 is a low-power microcontroller which runs MoteWorks from its internal flash memory. A single processor board (XM2110) can be configured to run your sensor application/processing and the network/radio communications stack simultaneously. The IRIS 51-pin expansion connector supports Analog Inputs, Digital I/O, I2C, SPI and UART interfaces. These interfaces make it easy to connect to a wide variety of external peripherals.

Sensor Boards

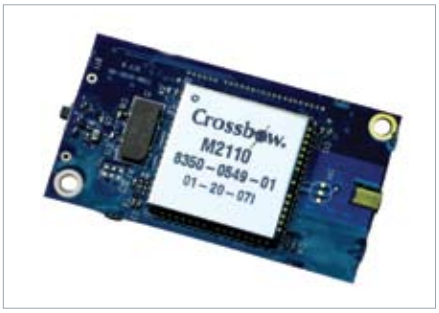
Crossbow offers a variety of sensor and data acquisition boards for the IRIS Mote. All of these boards connect to the IRIS via the standard 51-pin expansion connector. Custom sensor and data acquisition boards are also available. Please contact Crossbow for additional information.

Document Part Number: 6020-0124-01 Rev A

Processor/Radio Board	XM2110CA	Remarks
Processor Performance		
Program Flash Memory	128K bytes	
Measurement (Serial) Flash	512K bytes	> 100,000 Measurements
RAM	8K bytes	
Configuration EEPROM	4K bytes	
Serial Communications	UART	0-3V transmission levels
Analog to Digital Converter	10 bit ADC	8 channel, 0-3V input
Other Interfaces	Digital I/O,I2C,SPI	
Current Draw	8 mA	Active mode
	8 µA	Sleep mode (total)
RF Transceiver		
Frequency band[1]	2405 MHz to 2480 MHz	ISM band, programmable in 1 MHz steps
Transmit (TX) data rate	250 kbps	
RF power	3 dBm (typ)	
Receive Sensitivity	-101 dBm (typ)	
Adjacent channel rejection	36 dB	+ 5 MHz channel spacing
	34 dB	- 5 MHz channel spacing
Outdoor Range	> 300 m	1/4 wave dipole antenna, LOS
Indoor Range	> 50 m	1/4 wave dipole antenna, LOS
Current Draw	16 mA	Receive mode
	10 mA	TX, -17 dBm
	13 mA	TX, -3 dBm
	17 mA	TX, 3 dBm
Electromechanical		
Battery	2X AA batteries	Attached pack
External Power	2.7 V - 3.3 V	Molex connector provided
User Interface	3 LEDs	Red, green and yellow
Size (in)	2.25 x 1.25 x 0.25	Excluding battery pack
(mm)	58 x 32 x 7	Excluding battery pack
Weight (oz)	0.7	Excluding batteries
(grams)	18	Excluding batteries
Expansion Connector	51-pin	All major I/O signals

Notes

[1]5 MHz steps for compliance with IEEE 802.15.4/D18-2003.
Specifications subject to change without notice



IRIS Mote (bottom view)

MIB520CA Mote Interface Board

Base Stations

A base station allows the aggregation of sensor network data onto a PC or other computer platform. Any IRIS Mote can function as a base station when it is connected to a standard PC interface or gateway board. The MIB510 or MIB520 provides a serial/USB interface for both programming and data communications. Crossbow also offers a stand-alone gateway solution, the MIB600 for TCP/IP-based Ethernet networks.

Ordering Information

Model	Description
XM2110CA	2.4 GHz IRIS OEM Reference Board

Document Part Number: 6020-0124-01 Rev A

IRIS OEM EDITION

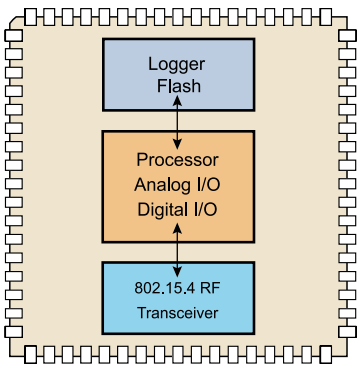
ADVANCED OEM MESH NETWORK RADIO MODULE

- OEM Module for Battery-Powered Mesh Network Sensor Nodes
- Postage Stamp Form Factor
- IEEE 802.15.4, 2.4 GHz Radio for up to 250 kbps Data Rate
- XMesh™ – Reliable, Self-forming, Self-healing Mesh Networking Protocol
- Analog and Digital I/O Interface for Easy Sensor Integration

Applications

- Battery-Powered Wireless Mesh Networking Devices
- 802.15.4 Compliant Wireless Mesh Networking Nodes
- Industrial, Structural and Security Monitoring
- Environmental, Physical, Health Maintenance
- Asset Management

ZigBee™Alliance



M2110CA Block Diagram

Actual Size

IRIS OEM EDITION

Crossbow's IRIS OEM Edition module, the M2110, provides users with high-level functional integration designed to optimize the addition of wireless mesh networking technology to a wide variety of both new and existing custom sensing applications.

Powerful new design features include:

- The IRIS OEM Edition is an advanced module with up to three times improved radio range and twice the program memory over previous generations of MICA Modules.
- Optimized processor/radio module integration based on Crossbow's extensive Mote development and deployment.
- Flexible onboard hardware interface for both standard and custom sensing devices.
- Comprehensive software support, including sensor board drivers and algorithms, via Crossbow's industry leading XMesh™ software technology.
- The IRIS OEM Edition is offered in a 68-pin LCC form factor for high-volume surface-mount integration.

By utilizing open-platform, standards based interfaces the OEM Module offer users an attractive value proposition consisting of easily differentiated, low-power 2.4 GHz IEEE 802.15.4 compliant radio modules that can be rapidly designed and built.

Processor and Radio Platform

- IEEE 802.15.4 compliant/ZigBee capable RF transceiver
- 2.4 GHz globally compatible ISM band
- Direct sequence spread spectrum radio for RF interference resistance and inherent data security
- 250 kbps high data rate radio.
- 68-pin package designed for easy sensor integration including light, temperature, RH, barometric pressure, acoustic, magnetic, acceleration/seismic, etc.

Software Support

- Optimized, industry proven, XMesh™ networking stack for low-power, self-forming, high reliability wireless networks
- Open interfaces for integration and customization of sensor node applications

Document Part Number: 6020-0123-01 Rev A

Processor/Radio Module	M2110CA	Remarks
Processor Performance		
Program Flash Memory	128K bytes	
Measurement Serial Flash	512K bytes	>100,000 measurements
Configuration EEPROM	4K bytes	
RAM	8K bytes	
Serial Communications	UART	0-3V transmission levels
Analog to Digital Converter	10 bit ADC	8 channels, 0-3V input
Other Interfaces	Digital I/O,I2C,SPI	
Current Draw	8 mA	Active mode
	8 µA	Sleep mode (total)
RF Transceiver		
Frequency Band[1]	2405 MHz to 2480 MHz	ISM band
Transmit (TX) Data Rate	250 kbps	
RF Power	3 dBm (typ)	
Receive Sensitivity	-101 dBm (typ)	
Adjacent Channel Rejection	36 dB	+ 5 MHz channel spacing
	34 dB	- 5 MHz channel spacing
Current Draw	16 mA	Receive mode
	10 mA	TX, -17 dBm
	13 mA	TX, -3 dBm
	17 mA	TX, 3 dBm
Electromechanical		
External Power	1.8V - 3.6V	
Size (in)	0.95 x 0.95 x 0.18	LCC68
(mm)	24.23 x 24.23 x 7.5	
Weight	0.11 oz, 3g	
Temperature Range	- 40 to 85°C	

Notes

[1]5 MHz steps for compliance with IEEE 802.15.4/D18-2003.
Specifications subject to change without notice

OEM Design Kit

For prototyping and development, Crossbow provides MoteWorks™, a fully integrated software platform and a complete OEM design kit, consisting of pre-programmed OEM Edition Reference Designs, OEM Edition Modules, sensor/data acquisition boards and an Ethernet base station. The MoteWorks™ software platform is optimized for low-power battery-operated networks providing an end-to-end platform across all tiers of wireless sensor networking applications.

OEM Design Kit

Ordering Information

Model	Description
M2110CA	2.4 GHz IRIS OEM Edition Module
Availability Q3	IRIS OEM Design Kit

Document Part Number: 6020-0123-01 Rev A

MICAz

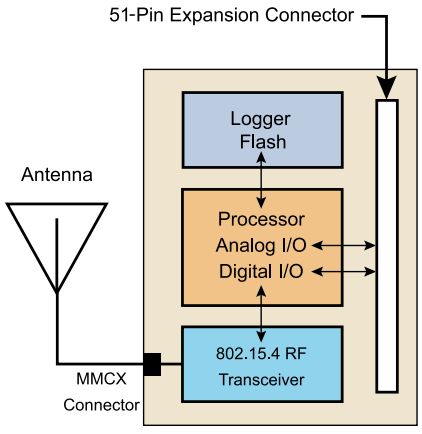
WIRELESS MEASUREMENT SYSTEM

- 2.4 GHz IEEE 802.15.4, Tiny Wireless Measurement System
- Designed Specifically for Deeply Embedded Sensor Networks
- 250 kbps, High Data Rate Radio
- Wireless Communications with Every Node as Router Capability
- Expansion Connector for Light, Temperature, RH, Barometric Pressure, Acceleration/Seismic, Acoustic, Magnetic and other Crossbow Sensor Boards

Applications

- Indoor Building Monitoring and Security
- Acoustic, Video, Vibration and Other High Speed Sensor Data
- Large Scale Sensor Networks (1000+ Points)

ZigBee™Alliance



MPR2400 Block Diagram

MICAz

The MICAz is a 2.4 GHz Mote module used for enabling low-power, wireless sensor networks.

Product features include:

- IEEE 802.15.4 compliant RF transceiver
- 2.4 to 2.48 GHz, a globally compatible ISM band
- Direct sequence spread spectrum radio which is resistant to RF interference and provides inherent data security
- 250 kbps data rate
- Supported by MoteWorks™ wireless sensor network platform for reliable, ad-hoc mesh networking
- Plug and play with Crossbow's sensor boards, data acquisition boards, gateways, and software

MoteWorks™ enables the development of custom sensor applications and is specifically optimized for low-power, battery-operated networks. MoteWorks is based on the open-source TinyOS operating system and provides reliable, ad-hoc mesh networking, over-the-air-programming capabilities, cross development tools, server middleware for enterprise network integration and client user interface for analysis and a configuration.

Processor & Radio Platform (MPR2400CA)

The MPR2400 is based on the Atmel ATmega128L. The ATmega128L is a low-power microcontroller which runs MoteWorks from its internal flash memory. A single processor board (MPR2400) can be configured to run your sensor application/ processing and the network/radio communications stack simultaneously. The 51-pin expansion connector supports Analog Inputs, Digital I/O, I2C, SPI and UART interfaces. These interfaces make it easy to connect to a wide variety of external peripherals. The MICAz (MPR2400) IEEE 802.15.4 radio offers both high speed (250 kbps) and hardware security (AES-128).

Sensor Boards

Crossbow offers a variety of sensor and data acquisition boards for the MICAz Mote. All of these boards connect to the MICAz via the standard 51-pin expansion connector. Custom sensor and data acquisition boards are also available. Please contact Crossbow for additional information.

Document Part Number: 6020-0060-04 Rev A

Processor/Radio Board	MPR2400CA	Remarks
Processor Performance		
Program Flash Memory	128K bytes	
Measurement (Serial) Flash	512K bytes	> 100,000 Measurements
Configuration EEPROM	4K bytes	
Serial Communications	UART	0-3V transmission levels
Analog to Digital Converter	10 bit ADC	8 channel, 0-3V input
Other Interfaces	Digital I/O,I2C,SPI	
Current Draw	8 mA	Active mode
	< 15 µA	Sleep mode
RF Transceiver		
Frequency band[1]	2400 MHz to 2483.5 MHz	ISM band, programmable in 1 MHz steps
Transmit (TX) data rate	250 kbps	
RF power	-24 dBm to 0 dBm	
Receive Sensitivity	-90 dBm (min), -94 dBm (typ)	
Adjacent channel rejection	47 dB	+ 5 MHz channel spacing
	38 dB	- 5 MHz channel spacing
Outdoor Range	75 m to 100 m	1/2 wave dipole antenna, LOS
Indoor Range	20 m to 30 m	1/2 wave dipole antenna
Current Draw	19.7 mA	Receive mode
	11 mA	TX, -10 dBm
	14 mA	TX, -5 dBm
	17.4 mA	TX, 0 dBm
	20 µA	Idle mode, voltage regular on
	1 µA	Sleep mode, voltage regulator off
Electromechanical		
Battery	2X AA batteries	Attached pack
External Power	2.7 V - 3.3 V	Molex connector provided
User Interface	3 LEDs	Red, green and yellow
Size (in)	2.25 x 1.25 x 0.25	Excluding battery pack
(mm)	58 x 32 x 7	Excluding battery pack
Weight (oz)	0.7	Excluding batteries
(grams)	18	Excluding batteries
Expansion Connector	51-pin	All major I/O signals

Notes
[1]5 MHz steps for compliance with IEEE 802.15.4/D18-2003.
Specifications subject to change without notice

MIB520CB Mote Interface Board

Base Stations

A base station allows the aggregation of sensor network data onto a PC or other computer platform. Any MICAz Mote can function as a base station when it is connected to a standard PC interface or gateway board. The MIB510 or MIB520 provides a serial/USB interface for both programming and data communications. Crossbow also offers a stand-alone gateway solution, the MIB600 for TCP/IP-based Ethernet networks.

Ordering Information

Model	Description
MPR2400CA	2.4 GHz MICAz Processor/Radio Board
WSN-START2400CA	2.4 GHz MICAz Starter Kit
WSN-PRO2400CA	2.4 GHz MICAz Professional Kit

Document Part Number: 6020-0060-04 Rev A

MICAz OEM EDITION

OEM MESH NETWORK RADIO MODULE

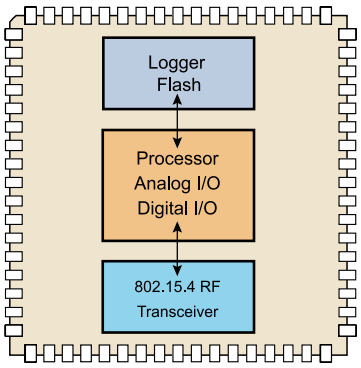
- OEM Module for Battery-Powered Mesh Network Sensor Nodes
- Postage Stamp Form Factor
- IEEE 802.15.4, 2.4 GHz Radio for up to 250 kbps Data Rate
- XMesh™ Mesh Networking Protocols
- Analog and Digital I/O Interface for Easy Sensor Integration

Actual Size

Applications

- Battery-Powered Wireless Mesh Networking Devices
- 802.15.4 Compliant Wireless Mesh Networking Nodes
- Industrial, Structural and Security Monitoring
- Environmental, Physical, Health Maintenance
- Asset Management

ZigBee™Alliance



MPR2600CA Block Diagram

MICAz OEM EDITION

Crossbow's MICAz OEM Edition module, the MPR2600, provides users with high-level functional integration designed to optimize the addition of wireless mesh networking technology to a wide variety of both new and existing custom sensing applications.

Powerful design features include:

- Optimized processor/radio module integration based on Crossbow's extensive Mote development and deployment.
- Flexible onboard hardware interface for both standard and custom sensing devices.
- Comprehensive software support, including sensor board drivers and algorithms, via Crossbow's industry leading XMesh™ software technology.

The MICAz OEM Edition is the functional equivalent of Crossbow's popular MPR2400 MICAz Mote in a postage stamp form factor. This inherent design continuity makes the MICAz OEM Edition an ideal solution for next-generation mesh networking products and designs. The MICAz OEM Edition is offered in a 68-pin LCC form factor for high-volume surface-mount integration.

By utilizing open-platform, standards based interfaces the OEM Module offers users an attractive value proposition consisting of easily differentiated, low-power 2.4 GHz IEEE 802.15.4 compliant radio modules that can be rapidly designed and built.

Processor and Radio Platform

- IEEE 802.15.4 compliant/ZigBee capable RF transceiver
- 2.4 GHz globally compatible ISM band
- Direct sequence spread spectrum radio for RF interference resistance and inherent data security
- 250 kbps high data rate radio.
- 68-pin package designed for easy sensor integration including light, temperature, RH, barometric pressure, acoustic, magnetic, acceleration/seismic, etc.

Software support

- Optimized, industry proven, XMesh™ networking stack for low-power, self-forming, high reliability wireless networks
- Open interfaces for integration and customization of sensor node applications

Document Part Number: 6020-0103-04 Rev A

Processor/Radio Module	MPR2600CA	Remarks
Processor Performance		
Program Flash Memory	128K bytes	
Measurement Serial Flash	512K bytes	>100,000 measurements
Configuration EEPROM	4K bytes	
RAM	4K bytes	
Serial Communications	UART	0-3V transmission levels
Analog to Digital Converter	10 bit ADC	8 channels, 0-3V input
Other Interfaces	Digital I/O,I2C,SPI	
Current Draw	8 mA	Active mode
	< 15 µA	Sleep mode
RF Transceiver		
Frequency Band[1]	2400 MHz to 2483.5 MHz	ISM band
Transmit (TX) Data Rate	250 kbps	
RF Power	3 dBm (max), 0 dBm (typ)	
Receive Sensitivity	-90 dBm (min), -94 dBm (typ)	
Adjacent Channel Rejection	45 dB	+ 5 MHz channel spacing
	30 dB	- 5 MHz channel spacing
Current Draw	19.7 mA	Receive mode
	11 mA TX, -10 dBm	
	14 mA TX, -5 dBm	
	17.4 mA TX, 0 dBm	
	1 µA	Sleep mode, voltage regulator off
Electromechanical		
External Power	2.4V - 3.6V	
Size (in)	0.95 x 0.95	LCC68
(mm)	24.13 x 24.13	

Notes

[1]5 MHz steps for compliance with IEEE 802.15.4/D18-2003.
Specifications subject to change without notice

OEM Design Kit

For prototyping and development, Crossbow provides MoteWorks™, a fully integrated software platform and a complete OEM Design kit, consisting of pre-programmed OEM Edition Reference Designs, OEM Edition Modules, sensor/data acquisition boards and an Ethernet base station. The MoteWorks™ software platform is optimized for low-power battery-operated networks providing an end-to-end platform across all tiers of wireless sensor networking applications.

OEM Design Kit

Ordering Information

Model	Description
MPR2600CA	2.4 GHz MICAz OEM Edition Module
WSN-OEM2400CA	2.4 GHz MICAz OEM Design Kit

Document Part Number: 6020-0103-04 Rev A

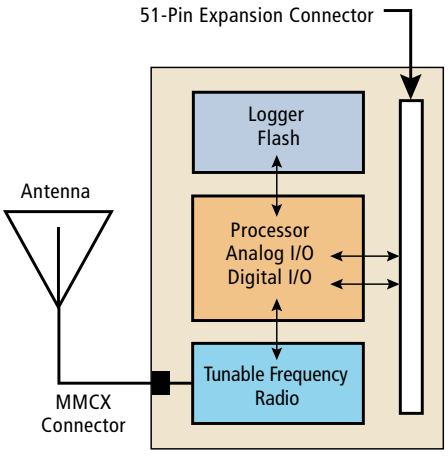
MICA2

WIRELESS MEASUREMENT SYSTEM

- 3rd Generation, Tiny, Wireless Platform for Smart Sensors
- Designed Specifically for Deeply Embedded Sensor Networks
- > 1 Year Battery Life on AA Batteries (Using Sleep Modes)
- Wireless Communications with Every Node as Router Capability
- 868/916 MHz Multi-Channel Radio Transceiver
- Expansion Connector for Light, Temperature, RH, Barometric Pressure, Acceleration/Seismic, Acoustic, Magnetic and other Crossbow Sensor Boards

Applications

- Wireless Sensor Networks
- Security, Surveillance and Force Protection
- Environmental Monitoring
- Large Scale Wireless Networks (1000+ points)
- Distributed Computing Platform



MPR400 Block Diagram

MICA2

The MICA2 Mote is a third generation mote module used for enabling low-power, wireless, sensor networks. The MICA2 Mote features several new improvements over the original MICA Mote. The following features make the MICA2 better suited to commercial deployment:

- 868/916 MHz multi-channel transceiver with extended range
- Supported by MoteWorks™ wireless sensor network platform for reliable, ad-hoc mesh networking
- Support for wireless remote reprogramming
- Wide range of sensor boards and data acquisition add-on boards

MoteWorks enables the development of custom sensor applications and is specifically optimized for low-power, battery-operated networks. MoteWorks is based on the open-source TinyOS operating system and provides reliable, ad-hoc mesh networking, over-the-air-programming capabilities, cross development tools, server middleware for enterprise network integration and client user interface for analysis and configuration.

Processor and Radio Platform (MPR400)

The MPR400 is based on the Atmel ATmega128L. The ATmega128L is a low-power microcontroller which runs MoteWorks from its internal flash memory. A single processor board (MPR400) can be configured to run your sensor application/processing and the network/radio communications stack simultaneously. The MICA2 51-pin expansion connector supports Analog Inputs, Digital I/O, I2C, SPI and UART interfaces. These interfaces make it easy to connect to a wide variety of external peripherals.

Sensor Boards

Crossbow offers a variety of sensor and data acquisition boards for the MICA2 Mote. All of these boards connect to the MICA2 via the standard 51-pin expansion connector. Custom sensor and data acquisition boards are also available. Please contact Crossbow for additional information.

Document Part Number: 6020-0042-08 Rev A

Processor/Radio Board	MPR400CB	Remarks
Processor Performance		
Program Flash Memory	128K bytes	
Measurement (Serial) Flash	512K bytes	>100,000 Measurements
Configuration EEPROM	4K bytes	
Serial Communications	UART	0-3V transmission levels
Analog to Digital Converter	10 bit ADC	8 channel, 0-3V input
Other Interfaces	DIO,I2C,SPI	
Current Draw	8 mA	Active mode
	< 15 µA	Sleep mode
Multi-Channel Radio		
Center Frequency	868/916 MHz	ISM bands
Number of Channels	4/ 50	Programmable, country specific
Data Rate	38.4 Kbaud	Manchester encoded
RF Power	-20 to +5 dBm	Programmable, typical
Receive Sensitivty	-98 dBm	Typical, analog RSSI at AD Ch. 0
Outdoor Range	500 ft	1/4 Wave dipole, line of sight
Current Draw	27 mA	Transmit with maximum power
	10 mA	Receive
	< 1 µA	Sleep
Electromechanical		
Battery	2X AA batteries	Attached pack
External Power	2.7 - 3.3 V	Connector provided
User Interface	3 LEDs	User programmable
Size (in)	2.25 x 1.25 x 0.25	Excluding battery pack
(mm)	58 x 32 x 7	Excluding battery pack
Weight (oz)	0.7	Excluding batteries
(grams)	18	Excluding batteries
Expansion Connector	51-pin	All major I/O signals

Notes: Specifications subject to change without notice

Base Stations

A base station allows the aggregation of sensor network data onto a PC or other computer platform. Any MICA2 Mote can function as a base station when it is connected to a standard PC interface or gateway board. The MIB510/MIB520 provides a serial/USB interface for both programming and data communications. Crossbow also offers a stand-alone gateway solution, the MIB600 for TCP/IP-based Ethernet networks.

MIB520 Mote Interface Board

Ordering Information

Model	Description
WSN-START900CA	MICA2 Starter Kit 868/916 MHz
WSN-PRO900CA	MICA2 Professional Kit 868/916 MHz
MPR400CB	868/916 MHz Processor/Radio Board

Document Part Number: 6020-0042-08 Rev A

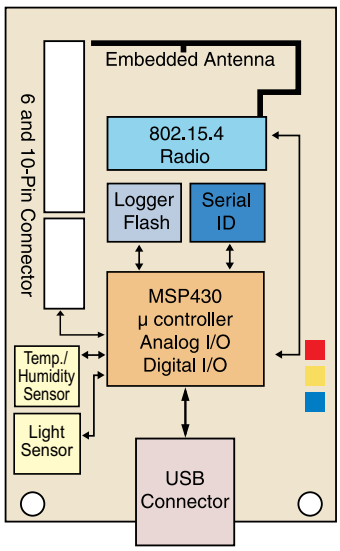
TELOSB

TELOSB MOTE PLATFORM

- IEEE 802.15.4 Compliant
- 250 kbps, High Data Rate Radio
- TI MSP430 Microcontroller with 10kB RAM
- Integrated Onboard Antenna
- Data Collection and Programming via USB Interface
- Open-source Operating System
- Integrated Temperature, Light and Humidity Sensor

Applications

- Platform for Low Power Research Development
- Wireless Sensor Network Experimentation



TPR2420CA Block Diagram

TELOSB

Crossbow's TelosB Mote TPR2420 is an open-source platform designed to enable cutting-edge experimentation for the research community. The TPR2420 bundles all the essentials for lab studies into a single platform including: USB programming capability, an IEEE 802.15.4 radio with integrated antenna, a low-power MCU with extended memory and an optional sensor suite. TPR2420 offers many features, including:

- IEEE 802.15.4 compliant RF transceiver
- 2.4 to 2.4835 GHz, a globally compatible ISM band
- 250 kbps data rate
- Integrated onboard antenna
- 8 MHz TI MSP430 microcontroller with 10kB RAM
- Low current consumption
- 1MB external flash for data logging
- Programming and data collection via USB
- Sensor suite including integrated light, temperature and humidity sensor
- Runs TinyOS 1.1.11 or higher

The TelosB platform was developed and published to the research community by UC Berkeley. This platform delivers low power consumption allowing for long battery life as well as fast wakeup from sleep state. The TPR2420 is compatible with the open-source TinyOS distribution.

TPR2420 is powered by two AA batteries. If the TPR2420 is plugged into the USB port for programming or communication, power is provided from the host computer. If the TPR2420 is always attached to the USB port no battery pack is needed.

TPR2420 provides users with the capability to interface with additional devices. The two expansion connectors and onboard jumpers may be configured to control analog sensors, digital peripherals and LCD displays.

TinyOS is a small, open-source, energy-efficient software operating system developed by UC Berkeley which supports large scale, self-configuring sensor networks. The source code software development tools are publicly available at: http://www.tinyos.net

Document Part Number: 6020-0094-02 Rev A

Specifications	TPR2420CA	Remarks
Module		
Processor Performance	16-bit RISC	
Program Flash Memory	48K bytes	
Measurement Serial Flash	1024K bytes	
RAM	10K bytes	
Configuration EEPROM	16K bytes	
Serial Communications	UART	0-3V transmission levels
Analog to Digital Converter	12 bit ADC	8 channels, 0-3V input
Digital to Analog Converter	12 bit DAC	2 ports
Other Interfaces	Digital I/O,I2C,SPI	
Current Draw	1.8 mA	Active mode
	5.1 µA	Sleep mode
RF Transceiver		
Frequency band[1]	2400 MHz to 2483.5 MHz	ISM band
Transmit (TX) data rate	250 kbps	
RF power	-24 dBm to 0 dBm	
Receive Sensitivity	-90 dBm (min), -94 dBm (typ)	
Adjacent channel rejection	47 dB	+ 5 MHz channel spacing
	38 dB	- 5 MHz channel spacing
Outdoor Range	75 m to 100 m	Inverted-F antenna
Indoor Range	20 m to 30 m	Inverted-F antenna
Current Draw	23 mA	Receive mode
	21 µA	Idle mode
	1 µA	Sleep mode
Sensors		
Visible Light Sensor Range	320 nm to 730 nm	Hamamatsu S1087
Visible to IR Sensor Range	320 nm to 1100nm	Hamamatsu S1087-01
Humidity Sensor Range	0-100% RH	Sensirion SHT11
Resolution	0.03% RH	
Accuracy	± 3.5% RH	Absolute RH
Temperature Sensor Range	-40°C to 123.8°C	Sensirion SHT11
Resolution	0.01°C	
Accuracy	± 0.5°C	@25°C
Electromechanical		
Battery	2X AA batteries	Attached pack
User Interface	USB	v1.1 or higher
Size (in)	2.55 x 1.24 x 0.24	Excluding battery pack
(mm)	65 x 31 x 6	Excluding battery pack
Weight (oz)	0.8	Excluding batteries
(grams)	23	Excluding batteries

TPR2420 with Sensor Suite

Notes

[1]Programmable in 1 MHZ steps, 5 MHz steps for compliance with IEEE 802.15.4/D18-2003.

Specifications subject to change without notice

Ordering Information

Model	Description
TPR2420CA	IEEE 802.15.4 TelosB Mote with Sensor Suite

Document Part Number: 6020-0094-02 Rev A

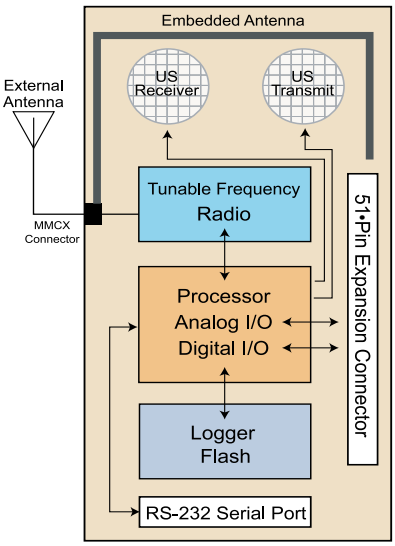
MCS410

CRICKET WIRELESS LOCATION SYSTEM

- High Performance MICA2 Wireless Location System
- Ultrasound Transmitter and Receiver for Time of Flight Ranging
- Centimeter Level Accuracy/ Resolution with Decentralized and Scalable Operation
- Embedded or External Antenna Option

Applications

- Indoor Location System
- Ubiquitous Computing
- Asset and People Tracking
- Ultrasound Location Research



MCS410CA Block Diagram

MCS410CA

The MCS410CA, Cricket Mote, is a location aware version of the popular MICA2 low-power Processor/Radio module. The Cricket Mote includes all of the standard MICA2 hardware and an Ultrasound transmitter and receiver. This device uses the combination of RF and Ultrasound technologies to establish differential time of arrival and hence linear range estimates.

Cricket Mote modules can beconfi-gured as both Listeners and Beacons. Beacons are placed throughout a building or facility and transmit concurrent RF and Ultrasound pulses. Listeners are attached to mobile devices and listen for RF signals. Upon receipt of the Beacon RF signal, the Listener then listens for the corresponding ultrasonic pulse. When this pulse arrives, the Listener obtains a distance estimate for the corresponding Beacon by taking advantage of the difference in propagation speed between RF and Ultrasound (speed of sound). The Listener runs algorithms that correlate RF and Ultrasound samples to pick the best correlation. Even in the presence of several competing Beacon transmissions, the Cricket Mote rapidly achieves impressive precision and accuracy.

Also known as the Cricket V2, the MCS410CA Mote module was devel-oped via joint design collaboration between Crossbow Technology and MIT. Using the same processor and radio components found on a standard 433 MHz MICA2 (MPR410), the MCS410CA offers the additional functionality of a direct connect RS-232 serial port.

More information on Cricket can be obtained at:
Cricket.csail.mit.edu

More information on TinyOS can be obtained at:
Webs.cs.Berkeley.edu

Ordering Information

Model	Description
MCS410CA	433 MHz Cricket Mote Platform

Document Part Number: 6020-0063-02 Rev A

SENSOR BOARDS

DATASHEETS

- MTS420 / 400
- MTS310 / 300 & MDA100
- MDA320
- MDA300

MTS420/400

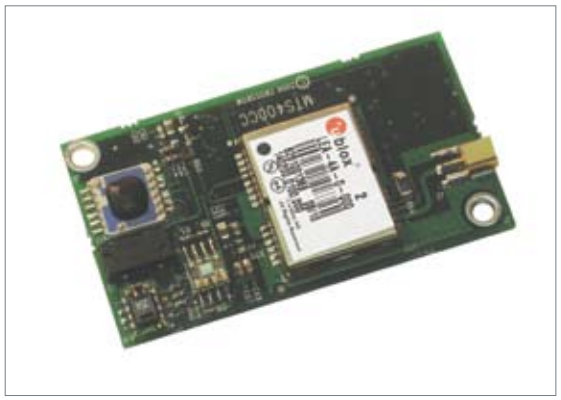
ENVIRONMENTAL SENSOR BOARD

- Compatible with MICAz/MICA2 Processor/ Radio Boards
- Onboard Temperature & Humidity, Barometric Pressure and Ambient Light Sensors
- Dual-Axis Accelerometer
- 64K EEPROM for User Configuration Data
- Optional GPS Module

Applications

- Agricultural Monitoring
- Art Preservation
- Environmental Monitoring
- Sensor Location Mapping* (*GPS Equipped)

MTS400CB



MTS420CC (with GPS Module)

MTS420/400

Developed in conjunction with UC Berkeley and Intel Research Labs, the MTS400 and MTS420 offer five basic environmental sensing parameters and an optional GPS module (MTS420).

These sensor boards utilize the latest generation of IC-based surface mount sensors. These energy-efficient digital devices in turn provide extended battery life and performance wherever low maintenance field-deployed sensor nodes are required.

These versatile sensor boards are intended for a wide variety of applications ranging from a simple wireless weather station to a full mesh network of environmental monitoring nodes. Applicable industries include Agricultural, Industrial, Forestry, HVAC and more.

Specifications:

Board

- Operating temp. range: -10°C to +60°C
- Operating humidity range 0% RH to 90% RH non-condensing

Dual-axis Accelerometer

- Analog Devices ADXL202JE
- Acceleration range; resolution: ±2 g; 2 mg at 60 Hz
- Nonlinearity: 0.2% of full scale
- Zero g bias level: 2.0 mg/°C from 25°C

Barometric Pressure Sensor

- Intersema MS5534AM
- Pressure range; resolution: 300-1100 mbar; 0.01 mbar
- Accuracy: ± 1.5% at 25°C

Ambient Light Sensor

- TAOS TSL2550D
- Spectral responsivity: 400-1000 nm, similar to human eye

Relative Humidity & Temperature Sensor

- Sensirion SHT11
- Humidity range; resolution: 0-100% RH; 0.03% RH
- Absolute RH accuracy: ± 3.5% RH
- Temp. accuracy: ± 0.5°C @ 25°C

GPS Module (MTS420CC only)

- ublox LEA-4A
- Tracking channels: 16
- L1 frequency: 1575.42 MHz C/A code
- Position accuracy: 10 m, 2D
- Reacquisition time: < 1 sec. (typ.); (<30 sec. max. blockage)

Ordering Information

Model	Description
MTS400CB	MICA2 Weather Sensor Board with Light, Temperature, Humidity, Barometric Pressure and Seismic
MTS420CC	MICA2 Weather Sensor Board Light, Temperature, Humidity, Barometric Pressure, Seismic and GPS

Document Part Number: 6020-0053-03 Rev A

MTS/MDA

SENSOR, DATA ACQUISITION BOARDS

- Selection of 3 Standard Sensor/DAQ Boards
- MoteWorks™ Drivers Support Sensor Readings
- Supports IRIS, MICAz and MICA2 Motes
- Individual Power Control for Each Sensor

Applications

- Vibration and Magnetic Anomaly Detection
- External Sensor Connection
- Localization and Acoustic Tracking
- Robotics
- Wireless Sensor Networking

MTS310CB

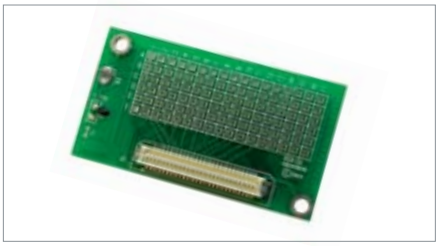
MTS310

The MTS310 is a flexible sensor board with a variety of sensing modalities. These modalities include a Dual-Axis Accelerometer, Dual-Axis Magnetometer, Light, Temperature, Acoustic and Sounder. The MTS310 is for use with the IRIS, MICAz and MICA2 Motes.

MTS300CB

MTS300

The MTS300CB is a flexible sensor board with a variety of sensing modalities. These modalities include Light, Temperature, Acoustic and Sounder. The MTS300CB is for use with the IRIS, MICAz and MICA2 Motes.



MDA100CB

MDA100

The MDA100CB sensor and data acquisition board has a precision thermistor, a light sensor/photocell and general prototyping area. Designed for use with the IRIS, MICAz and MICA2 Motes, the prototyping area supports connection to all 51 pins on the expansion connector, and provides an additional 42 unconnected solder points for breadboarding.

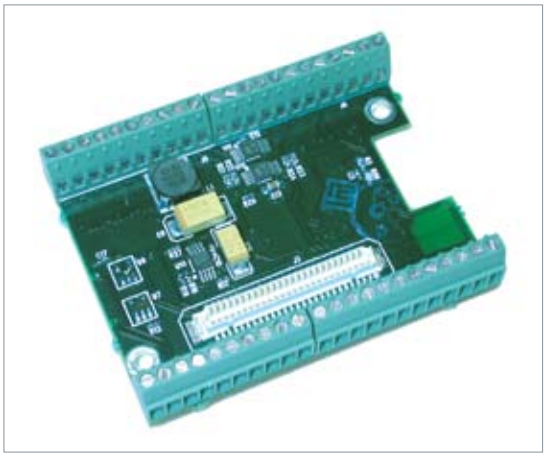
Ordering Information

Model	Description
MTS310CB	Light, Temperature, Acoustic, Sounder, Dual-Axis Accel and Dual-Axis Mag Sensor Board
MTS300CB	Light, Temperature, Acoustic and Sounder Sensor Board
MDA100CB	Light, Temperature, Prototype Area Sensor/DAQ Board

Document Part Number: 6020-0047-03 Rev A

MDA300

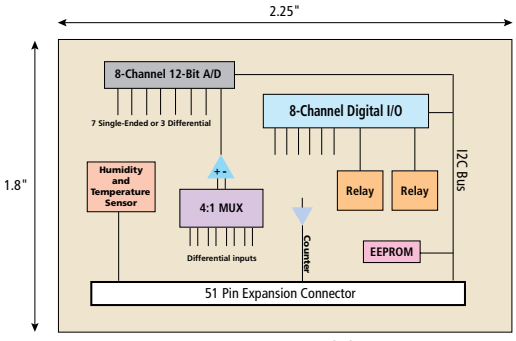
DATA ACQUISITION BOARD



- Multi-Function Data Acquisition Board with Temp, Humidity Sensor
- Compatible with MoteView Driver Support
- Up to 11 Channels of 12-bit Analog Input
- Onboard Sensor Excitation and High-Speed Counter
- Convenient Micro-Terminal Screw Connections

Applications

- Environmental Data Collection
- Agricultural and Habitat Monitoring
- Viticulture and Nursery Management
- HVAC Instrumentation and Control
- General Data Collection and Logging



MDA300C Block Diagram

MDA300

Developed at UCLA's Center for Embedded Network Sensing (CENS), the MDA300 is an extremely versatile data acquisition board that also includes an onboard temperature/ humidity sensor. With its multi-function direct user interface, the MDA300 offers a convenient and flexible solution to those sensor modalities commonly found in areas such as environmental and habitat monitoring as well as many other custom sensing applications.

As part of a standard mesh network of Motes, the MDA300's easy access micro-terminals also make it an economical solution for a variety of applications and a key component in the next generation of low-cost wireless weather stations. Data logging and display is supported via Crossbow's MoteView user interface.

Crossbow's MoteView software is designed to be the primary interface between a user and a deployed network of wireless sensors. MoteView provides an intuitive user interface to database management along with sensor data visualization and analysis tools. Sensor data can be logged to a database residing on a host PC, or to a database running autonomously on a Stargate gateway.

Communication and Control Features Including:

- 7 single-ended or 3 differential ADC channels
- 4 precise differential ADC channels
- 6 digital I/O channels with event detection interrupt
- 2.5, 3.3, 5V sensor excitation and low-power mode
- 64K EEPROM for onboard sensor calibration data
- 2 relay channels, one normally open and one normally closed
- 200 Hz counter channel for wind speed, pulse frequencies
- External I2C interface

Drivers for the MDA300 board are included in Crossbow's MoteWorks™ software platform. MoteWorks enables the development of custom sensor applications and is specifically optimized for low-power, battery-operated networks. MoteWorks is based on the open-source TinyOS operating system and provides reliable, ad-hoc mesh networking, over-the-air-programming capabilities, cross development tools, server middleware for enterprise network integration and client user interface for analysis and configuration.

Ordering Information

Model	Description
MDA300CA	Mote Data Acquistion Board with Temperature and Humidity

Document Part Number: 6020-0052-03 Rev A

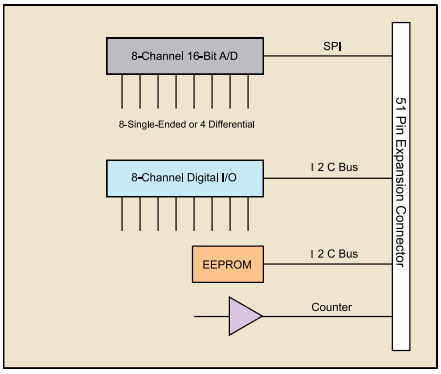
MDA320

DATA ACQUISITION BOARD

- Multi-Function Data Acquisition Board
- Compatible with MoteView Driver Support
- Up to 8 Channels of 16-bit Analog Input
- Onboard Sensor Excitation and High-Speed Counter
- Convenient Micro-Terminal Screw Connections

Applications

- Industrial Vibration Monitoring
- Seismic and Acoustic Analysis
- Controlled Environment Agriculture
- HVAC Instrumentation and Control
- Environmental Data Collection



MDA320CA Block Diagram

MDA320CA

The MDA320CA is a high-performance data acquisition board with up to 8 channels of 16-bit analog input. It combines a reduced feature set with the same versatile functionality found in Crossbow's popular MDA300 data acquisition board. This board is designed for use in cost-sensitive applications requiring precision data collection and analysis.

With improved micro-terminal connections, the MDA320CA offers users a rapid and convenient interface to a wide variety of discrete external sensing devices. Data logging and display is supported via Crossbow's MoteView user interface.

Crossbow's MoteView software is designed to be the primary interface between a user and a deployed network of wireless sensors. MoteView provides an intuitive user interface to database management along with sensor data visualization and analysis tools. Sensor data can be logged to a database residing on a host PC, or to a database running autonomously on a Stargate gateway.

Communication and control features include:

- 8 single-ended 0-2.5V inputs, or 4 differential 0-2.5V ADC channels
- 8 digital 0-2.5V I/O channels with event detection interrupt
- 2.5, 3.3, 5V battery sensor excitation and low-power mode
- 64K EEPROM for onboard sensor calibration data
- 200 Hz counter channel for wind speed, pulse frequencies
- External I2C interface

Drivers for the MDA300 board are included in Crossbow's MoteWorks™ software platform. MoteWorks enables the development of custom sensor applications and is specifically optimized for low-power, battery-operated networks. MoteWorks is based on the open-source TinyOS operating system and provides reliable, ad-hoc mesh networking, over-the-air-programming capabilities, cross development tools, server middleware for enterprise network integration and client user interface for analysis and configuration.

Ordering Information

Model	Description
MDA320CA	Mote Data Acquistion Board

Document Part Number: 6020-0100-02-A

GATEWAYS

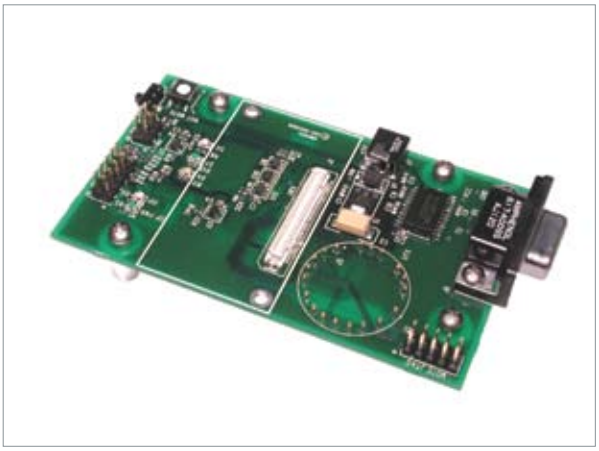
DATASHEETS

- MIB510
- MIB520
- MIB600
- STARGATE

MIB510

SERIAL INTERFACE BOARD

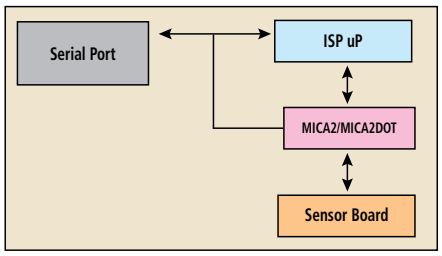
- Base Station for Wireless Sensor Networks
- Serial Port Programming for IRIS, MICAz and MICA2 Hardware Platforms
- Supports JTAG code debugging



Applications

- Programming Interface
- RS-232 Serial Gateway
- IRIS, MICAz, MICA2 Connectivity

MIB510 with Mote and Sensor Board



MIB510 Block Diagram

MIB510

The MIB510 allows for the aggregation of sensor network data on a PC as well as other standard computer platforms. Any IRIS/MICAz/MICA2 node can function as a base station when mated to the MIB510 serial interface board. In addition to data transfer, the MIB510 also provides an RS-232 serial programming interface.

The MIB510 has an onboard processor that programs the Mote processor/radio boards. The processor also monitors the MIB510 power voltage and disables programming if the voltage is not within the required limits. Two 51-pin Hirose connectors are available, allowing sensor boards to be attached for monitoring or code development. The MIB510 is also compatible with the Atmel JTAG pod for code development.

Specifications

RS-232 Interface

- Connector: 9-pin "D"
- Baud Rates:
  - User defined (57.6k typical)
  - Programming: 115.2k (uisp controlled)

Mote Interface

- Connectors:
  - 51 pin (2)
- Indicators:
  - Mote LEDs: Red, Green, Yellow

Programming Interface

- Indicators:
  - LEDs - Power Ok (Green), Programming in Progress (Red)
- Switches:
  - On/Off switch to disable the Mote serial transmission
  - Temporary switch to reset the programming processor and Mote

Jtag Interface

- Connector: 10-pin male header (2)

Power

- 5V @ 50mA using external power supply (included with unit)
- 3.3-2.7V @ 50mA using Mote batteries

Ordering Information

Model	Description
MIB510	Serial PC Interface Board

Document Part Number: 6020-0057-03 Rev A

MIB520

USB INTERFACE BOARD

- Base Station for Wireless Sensor Networks
- USB Port Programming for IRIS/MICAz/MICA2 Hardware Platforms
- Supports JTAG code debugging
- USB Bus Power

Applications

- USB Interface
- Testbed Deployments
- In-System Programming

MIB520CB with attached Mote

MIB520CB

The MIB520CB provides USB connectivity to the IRIS and MICA family of Motes for communication and in-system programming. Any IRIS/MICAz/MICA2 node can function as a base station when mated to the MIB520CB USB interface board. In addition to data transfer, the MIB520CB also provides a USB programming interface.

The MIB520CB offers two separate ports: one dedicated to in-system Mote programming and a second for data communication over USB.The MIB520CB has an on-board processor that programs Mote Processor Radio Boards. USB Bus power eliminates the need for an external power source.

Specifications

USB Interface

- Baud Rate: 57.6 K
- Male to Female USB cable (included with unit)

Mote Interface

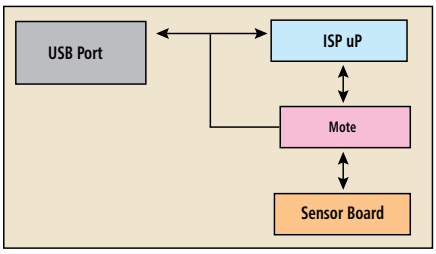
- Connectors:
  - 51-pin
- Indicators:
  - Mote LED's: Red Green, Yellow

Programming Interface

- Indicators:
  - LEDs - Power Ok (Green), Programming in Progress (Red)
- Switch to reset the programming processor and Mote.

Jtag Interface

- Connector: 10-pin male header POWER
- USB Bus powered



MIB520CB Block Diagram

Ordering Information

Model	Description
MIB520CB	USB PC Interface Board

Document Part Number: 6020-0091-03 Rev A

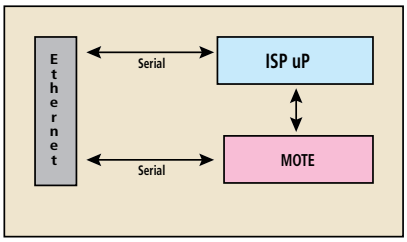
MIB600

ETHERNET INTERFACE BOARD

- Base Station/Ethernet Gateway for Wireless Sensor Networks
- Mote Network Testbed
- Remote In-System Programming for IRIS/MICAzMICA2 Processor/Radio Boards
- Full TCP/IP Protocol
- Power Over Ethernet (POE) Ready

Applications

- Ethernet Network Interface
- Testbed Deployments
- In-System Programming
- Network Connectivity via TCP/IP



MIB600 Block Diagram

MIB600

The MIB600 provides Ethernet (10/100 Base-T) connectivity to the IRIS/MICAz/MICA2 family of motes for communication and in-system programming. The MIB600 allows remote access to sensor network data via TCP/IP. The MIB600 serial server connects directly to a 10 Base-T LAN like any other network device. The MIB600 can bridge "wired" and "wireless" segments of a network. The MIB600 is also an effective conduit for sensor data.

The MIB600 offers two separate ports: One dedicated to in-system Mote programming and a second for routine data communication over the LAN. The built-in Power Over Ethernet (POE) feature eliminates the need for an external power source, simplifying installation and maintenance.

Specifications

Ethernet Network Interface

- RJ-45
- 100 Base
- IEEE 802.3 / IEEE 802.3af POE mid-span PSE compatible
- ARP, UDP/IP, TCP/IP, Telnet, DHCP, BOOTP, TFTP, Auto IP, and HTTP
- Indicators: 10 Base-T & 100 Base-TX

LAN Interface

- Internal web server, serial login, telnet login
- Security: password protection, locking features

Mote Interface

- Connector: 51-pin expansion
- Interface: UART
- 9.6-115.2 k baud
- Mote LEDs - red, green, yellow, power OK
- Management: dedicated TCP/IP port for mote UART

In-system Programming

- Protocol: UISP
- ISP active LED
- Dedicated TCP/IP port for InSystem programming
- Remote Mote RESET

Physical And Environmental

- Size: (L x W x H)
  4.63" x 2.29" x 1"
  11.76cm x 5.82cm x 2.54cm
- IEEE 802.3af POE 5V/082
- Shipped with external power supply

Ordering Information

Model	Description
MIB600	Ethernet PC Interface Board

Document Part Number: 6020-0055-04 Rev A

STARGATE

X-SCALE, PROCESSOR PLATFORM

- 400 MHz, Intel PXA255 Processor
- Low Power Consumption <500 mA
- Embedded Linux BSP Package, Source Code Shipped with Kit
- Small, 3.5" x 2.5" Form Factor
- PCMCIA and Compact Flash Connector
- 51-pin Expansion Connector for IRIS/MICAz/MICA2 Motes and other Peripherals
- Ethernet, Serial, JTAG, USB Connectors via 51-pin Daughter Card Interface
- Li-Ion Battery Option

Applications

- Sensor Network Gateway
- Robotics Controller Card
- Distributed Computing Platform

STARGATE

The Stargate is a high-performance processing platform designed for sensor, signal processing, control and wireless sensor networking applications and is based on Intel's Xscale® processor.

The Stargate processor board is the result of the combined design efforts of several different Ubiquitous Computing research groups within Intel. The completed design is licensed to Crossbow Technology for commercial production. The Stargate processor board is preloaded with a Linux distribution and basic drivers. A variety of useful applications and development tools are also provided.

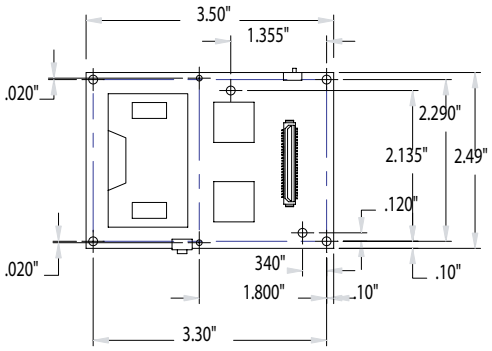
The Stargate processor module is compatible with Crossbow's IRIS/MICAz/MICA2 family of wireless sensor networking products and the public domain software from Intel's Open-Source Robotics initiative. The Stargate processor module is also an ideal solution for standalone Linux-based Single Board Computer (SBC) applications.

With its strong communications capability and Crossbow's ongoing commitment to its open-source architecture, the Stargate platform offers tremendous flexibility. The SPB400CB Processor Board has both Compact Flash and PCMCIA connectors as well as optional installable headers for 2 serial ports and an I2C port. The SDC400CA Daughter Card supports a variety of additional interfaces, including:

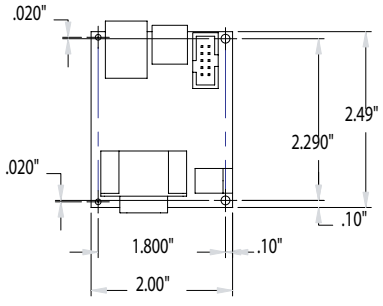
- RS-232 Serial
- 10/100 Ethernet
- USB Host
- JTAG

Finally, the standard Mote connector on the SPB400CB Processor Board provides support for synchronous serial port (SSP), UART, and other GPIO connections.

Processor Board



Daughter Card



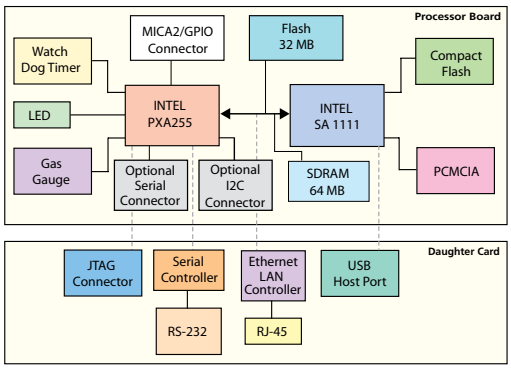
Document Part Number: 6020-0049-05 Rev A

Specifications	Remarks
STARGATE Processor Board	
Intel PXA255, Xscale®	400 MHz, RISC Processor
Intel SA1111, StrongARM®	Multiple I/O Companion Chip
Memory	
64 MB SDRAM	
32 MB FLASH	Linux Software < 10 MBytes
Communications	
PCMCIA Slot	Type II
Compact Flash Slot	Type II
51-pin GPIO	UART, SSP via Mote Connector
Optional I2C Port	Installable Header
Optional Serial Port (2)	Installable Header
General	
Li-Ion Battery Option	
Watch Dog Timer (WDT)	Configurable up to 60 seconds
Battery Gas Gauge	
LED and User Application Switch	
Power Switch	
STARGATE Daughter Card	
Communications	
10 Base-T Ethernet Port	RJ-45 Connector
RS-232 Serial Port	DB-9 Connector
JTAG Debug Port	
USB Host Port	Version 1.1
General	
A/C Power Adaptor	5-6 VDC, 1 Amp
Reset Button	
Real-Time Clock	
Physical	
Processor Board (in)	3.50 x 2.49 x 0.73
(cm)	9.53 x 6.33 x 1.86
Weight (oz)	1.68
(g)	47.47
Daughter Card (in)	2.49 x 2.00 x 0.60
(cm)	6.33 x 5.08 x 1.52
Weight (oz)	1.42
(g)	40.16
Environmental	
Operating Temperature	0 to +70 (°C)

Specifications subject to change without notice

Processor Board - Top

Daughter Card



Stargate Block Diagram

Stargate Kit Contents
Stargate Processor Board
Stargate Daughter Card
Power Supply
Null Modem Cable
CD-ROM
CD-ROM Contents
Linux - Kernel & Driver Sources
GNU Cross Platform Dev. Tools
Bootloader with Source Code
Flash Programming Utility
Shareware & Test Applications
Developer's Guide - PDF Format

Ordering Information

Model	Description
SP-KIT400CA	Stargate Developer's Kit
SPB400CB	Stargate Processor Board
SDC400CA	Stargate Daughter Card - JTAG, 10/100 Ethernet, Serial, USB Host

Document Part Number: 6020-0049-05 Rev A

SOFTWARE

DATASHEETS

- MOTEWORKS™ 2.0

MOTEWORKS™

SOFTWARE PLATFORM

MoteWorks™ 2.0 provides a complete software development environment for wireless sensor network applications. Included is a collection of flexible software packages that enables both quick-and-easy out-of-the-box deployment of sensor systems for monitoring and alerting, to powerful tools to empower custom development of pervasive sensory networks.

Key Features

- Supports all Crossbow MICA and IRIS series Mote hardware and sensor boards:
  - **Motes:** IRIS, MICAz, MICA2, MICA2DOT
  - **Sensors:** MDA100/300/320, MTS300/310/400/410/420, MEP410/510
- Simple one-click installation and upgrade
- Based on TinyOS 1.1, a popular Open Source embedded operating system
- Source level access for modification and custom development
- **MoteView:** Rich interface for visualization and analysis of sensor data streams
- **MoteConfig:** Simple graphical interface to program flash and configure firmware images
- **XMesh:** Reliable mesh networking stack
- **XOtap:** Over-the-air firmware reprogramming
- **XRadio:** Low power radio protocol for battery powered devices
- **XServe:** Powerful utilities for data logging, parsing, conversions, and alerts
- **XSniffer:** Displays radio communication for protocol debugging
- **XSensor:** Complete set of example sensor applications
- **Cygwin:** Command line shell and development environment
- **Programmers Notepad:** Rich text editor and compilation front-end
- **nesC:** Pre-compiler language for generating ultra-efficient embedded software
- **gcc:** Industry standard C language cross-compiler
- **TortoiseCVS:** File Manager integrated revision control interface
- **WinMerge:** Graphical source revision differencing tool

Overview

A wireless network deployment is composed of the three distinct software tiers:

1. The **Mote Tier**, where XMesh resides, is the software that runs on the cloud of sensor nodes forming a mesh network. The XMesh software provides the networking algorithms required to form a reliable communication backbone that connects all the nodes within the mesh cloud to the server.
2. The **Server Tier** is an always-on facility that handles translation and buffering of data coming from the wireless network and provides the bridge between the wireless Motes and the internet clients. XServe is the primary server tier application, and can run on a PC or Gateway.
3. The **Client Tier** provides the user visualization software and graphical interface for managing the network. Crossbow provides an analysis and monitoring package called MoteView for the client tier, but XMesh can be interfaced to custom 3rd party client software as well.

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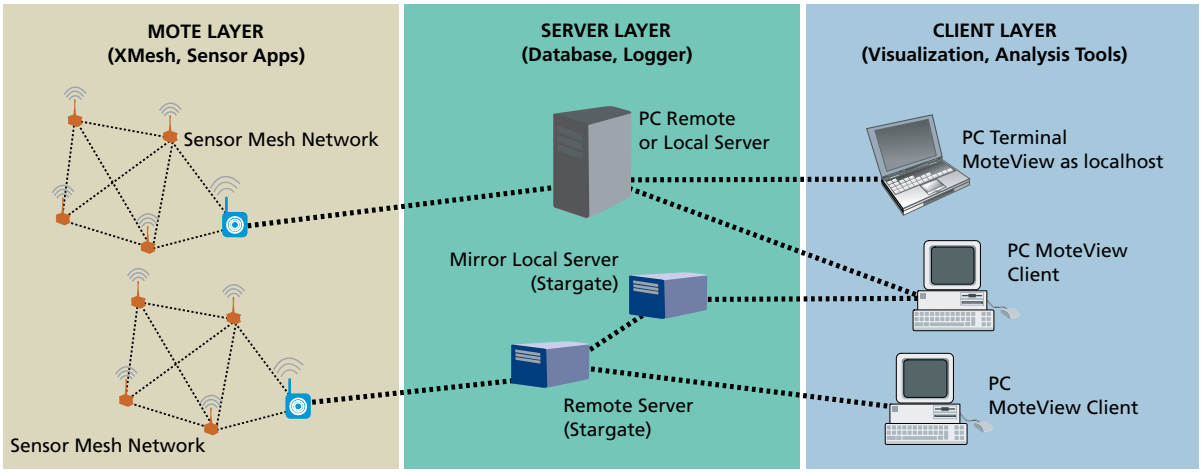


Figure1.1
Software Framework for a Wireless Sensor Network

XMesh

XMesh is a reliable, low power, mesh networking library included in the MoteWorks package. XMesh provides higher reliability and lower power operation than other packages available in Open Source.

Package	Module	Reliability
MoteWorks 2.0	XMesh	95 - 99.9%
TinyOS 1.1	MintRoute	65 - 70%

Key Features of XMesh 2.0 Include

- **Fast Formation** – Network forms in seconds compared to hours with other solutions.
- **Responsiveness** – Supports low-latency, sub-second alarm delivery across multiple hops.
- **Self-healing** – Network continuously assesses link quality and adjusts accordingly.
- **Reliability** – Over 95% reliability without any end-to-end retries.
- **Guaranteed Delivery** – Achieve 99.9% reliability by enabling end-to-end acknowledgement.
- **Bi-directional Delivery** – Send commands to any node using directed downstream service.
- **Scalability** – Supports clusters of 100+ nodes.
- **Proven Low Power** – LP and ELP topologies with known characterized battery life.
- **Low Power Router** – Supports full mesh topology with all nodes powered by battery.
- **End Node Support** – ELP service provides ultra low power hybrid-star end nodes.
- **Full Range** – Low power protocol provides Uncompromised full radio range.
- **Documented API** – Extensive manual describing services and development model.

XOTAP

Crossbow provides a unique OTAP (Over-the-air Programming) capability that is superior to Open Source solutions such as Deluge for the following reasons:

- **Highly Reliable** – Directed dissemination with acknowledgement of completion and success.
- **Heterogeneous** – Allows programming of different firmware to different nodes in the network.

(Deluge propagates the same image to all devices.)

Feature	Module XOtap	Deluge
Images per node	4	2
Over-the-air programming	XMesh	X
Command-line tool	X	X
Management GUI tool	X	
Heterogeneous network	X	

Document Part Number: 6030-0001-02 Rev A

XServe

MoteWorks includes a powerful connectivity solution between wireless sensor networks and Enterprise networks in the form of XServe. Open source has no middleware for connecting a sensor network to an IT network or a legacy process control / industrial automation network. In addition, the MoteWorks Base station software has been stress tested for long term stability, and includes reliability extensions.

- **Database Logging** – Logs data into an SQL database (PostgreSQL).
- **File Logging** – Logs data into a CSV file format.
- **Modbus Support** – Bridges a WSN to a legacy network through Modbus interface.
- **TCP/IP Support** – Bridges WSN data into standard IP communication protocol.
- **XML-RPC Support** – Configures WSN nodes through standard distributed object protocols.
- **Flexible Parsing** – Supports custom packet formats with auto-generated XML configuration.
- **Unit Conversions** – Seemlessly Converts raw ADC sensor values to final engineering units.

Developer Tools

MoteWorks provides a complete Windows based development environment through a simple single-click installer. MoteWorks also provides a simple Windows interface for viewing, editing, compiling, and downloading code. For the open source developer, familiar tools like 'vi' and 'cmacs' and command-line driver development is supported.

MoteView

MoteView provides visualization and analysis of multiple sensor data streams. MoteView comes with pre-compiled firmware for simple deployment of periodic sensing applications.

Key Features of MoteView 2.0 Include

- **Simple Out-of-Box Experience** – Get your WSN kit up and running fast.
- **Charting** – Graph sensor data over time with zoom/pan tools for detailed analysis.
- **Topology** – Overlay network linkage on custom bitmap with isobar display of sensor data.
- **Data Grid** – Tabular display of sensor data across all nodes.
- **Time Bar** – Scroll backward and forward in time, and playback sensor data as movie.
- **Health** – Quickly view node outages, and detailed link quality information.
- **Export** – Manage database with import / export from SQL to CSV formats.
- **Commands** – Simple interface to control and actuate individual nodes.
- **Alerts** – Send an email or text page when a sensor value crosses a critical threshold.

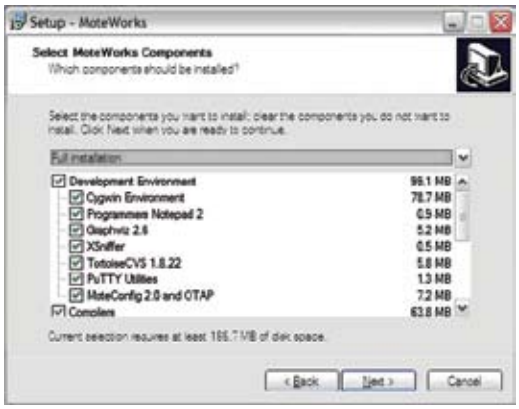
Why MoteWorks?

MoteWorks provides the following benefits over TinyOS 1.x or TinyOS 2.x:

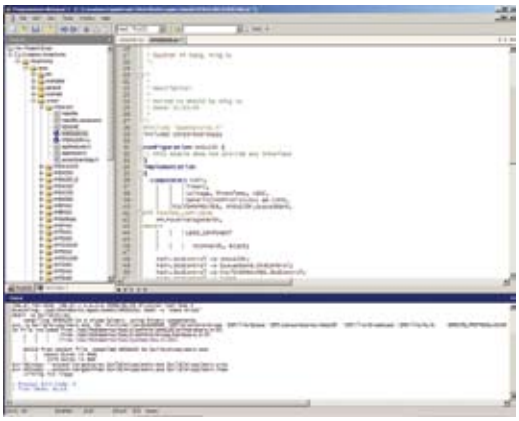
1. Faster network formation time (5x improvement)
2. Enhanced data transfer success rate (success rate went up from <70% to >95%)
3. API interface to proven XMesh routing stack (upstream and downstream)
4. Multiple topology support (Star, TrueMesh and Hybrid-Star)
5. Reliable and targeted XOtap (vs. dangerous viral propagation with Deluge)
6. IDE-like interface for compiling/debugging (vs. vi editor) and GUI interface for programming.
7. XML/Web interface via XServe for enterprise connectivity
8. One-click installer for quick start (vs. multiple install steps)
9. Plug and Play support for entire Crossbow hardware suite
10. Crossbow's professional support for bug fixes and potenial custom enhancement requests (vs cry for help at TinyOS forum).

MoteWorks Walk-through

1. Simple single-click installer will equip your machine with all the tools and configuration needed.



2. Programmers Notepad provides code highlighting and points out errors in the code to the user.



3. MoteView provides visualization and analysis of multiple sensor data streams. MoteView comes with pre-compiled firmware for simple deployment of periodic sensing applications.

Figure 1. MoteView – Topology

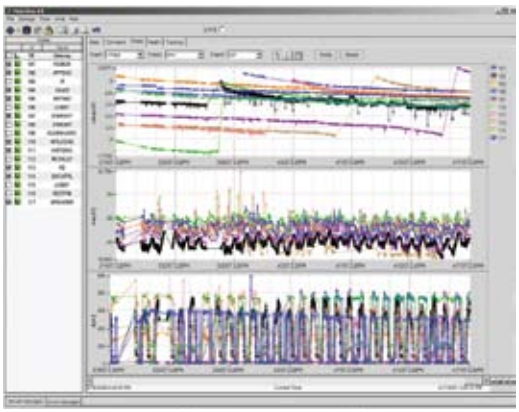


Figure 2. MoteView – Charts

MoteWorks Walk-through

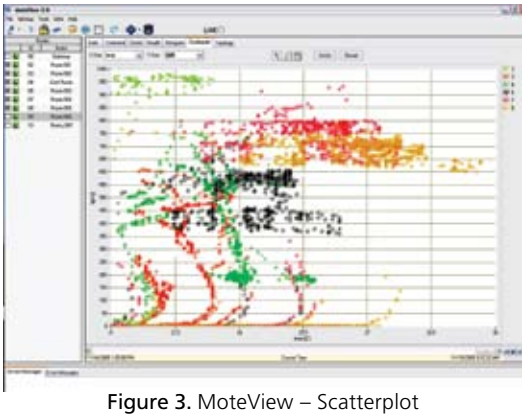


Figure 3. MoteView – Scatterplot

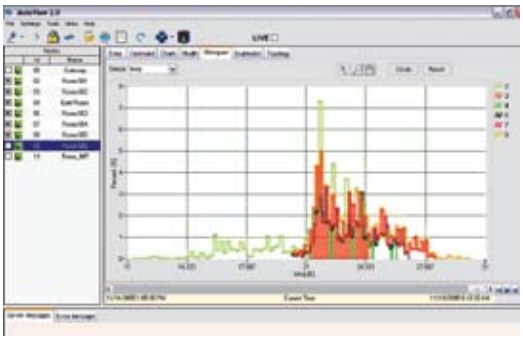
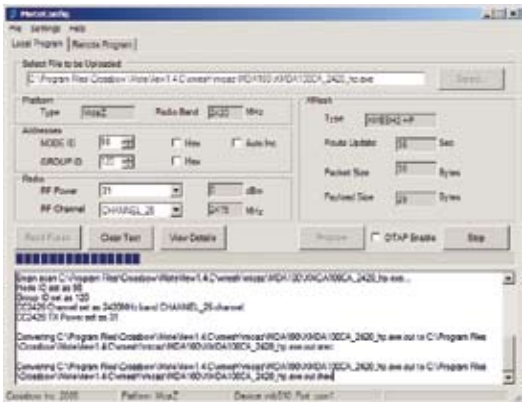
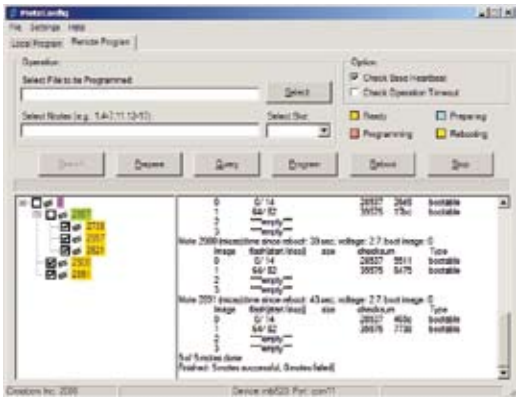


Figure 4. MoteView – Histogram

4. MoteConfig enables both local and remote (over-the-air) programming of firmware to the wireless sensor devices.



MoteConfig – Local Programming



MoteConfig – Remote Programming (OTAP)

5. XSniffer network radio protocol analyzer.

Figure 8 4. Screenshot displaying XSniffer Output

License Terms

The entire suite of MoteWorks software is, or will soon be available, for free download from Crossbow's website, http://www.xbow.com. All binaries and substantial source code are included as part of these free distributions. The end-user license agreement provides for redistribution and use, for an unlimited time and at no cost, for most uses that are academic, research, personal, evaluative, or non-profit in nature. Licenses for commercial use without geographic or time limitation are available from Crossbow, and may include certain source code that is not included in the standard release. Please contact sales@xbow.com for more information.

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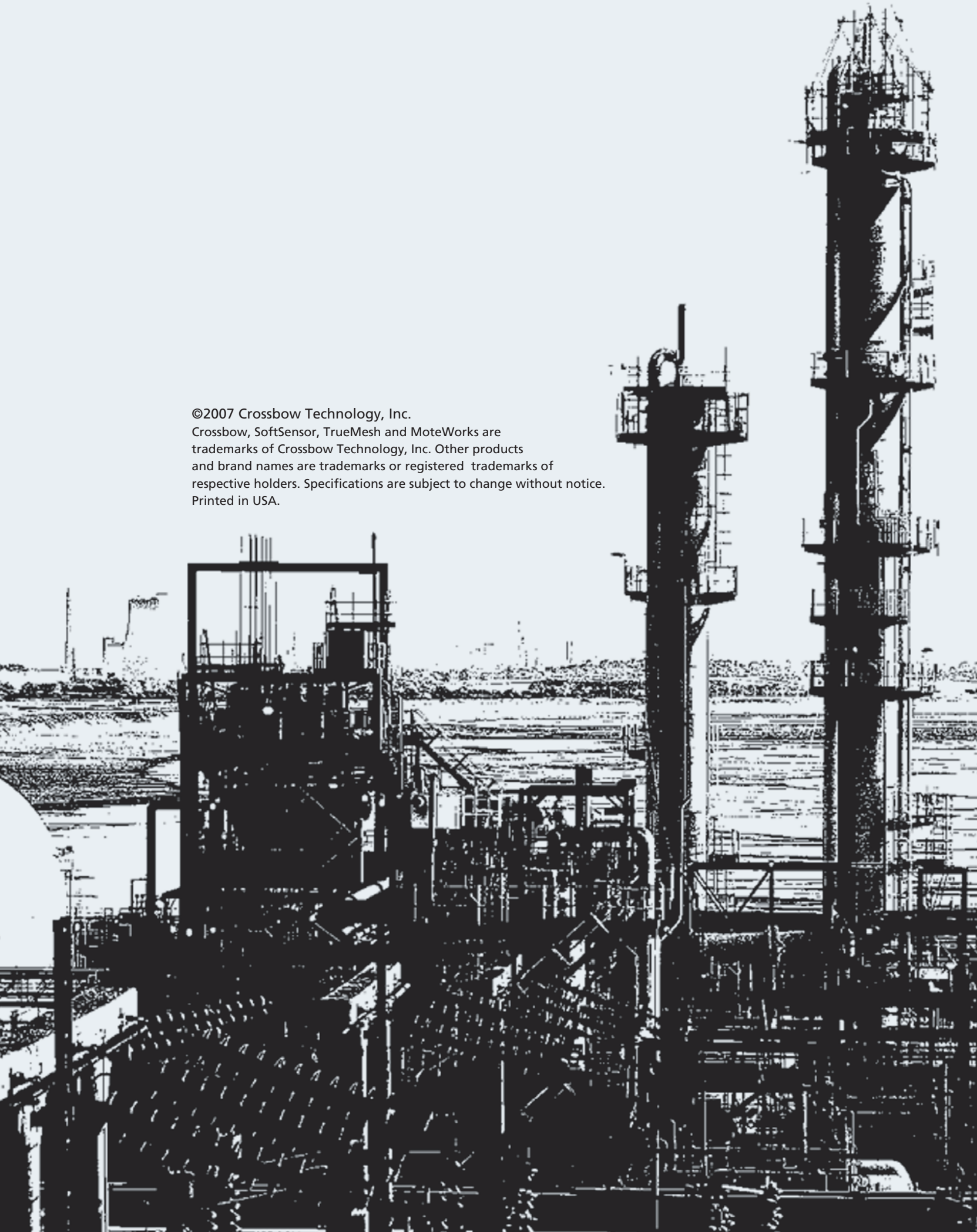

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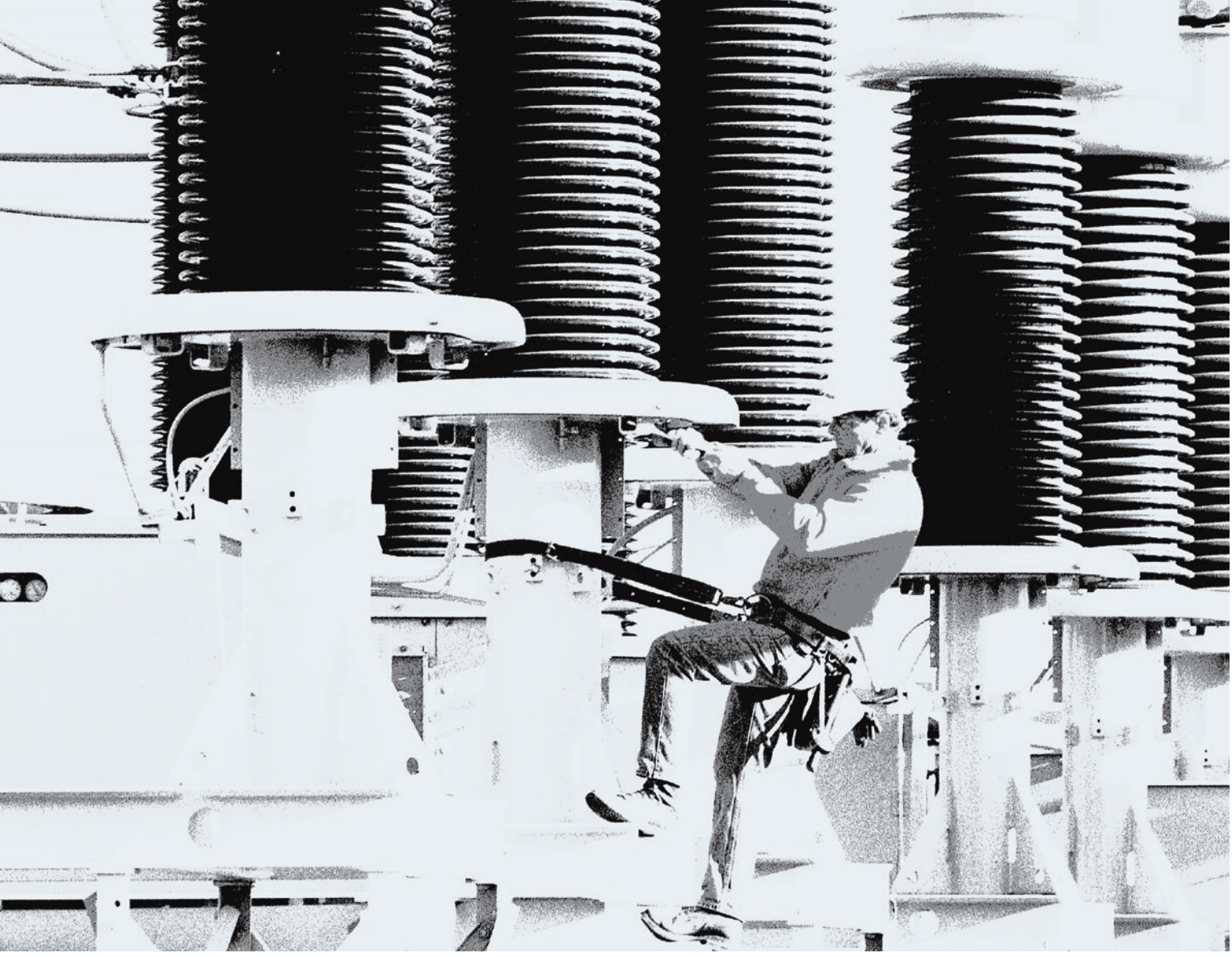

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